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Raz

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(54) **DOOR WITH SUPPLEMENTARY HINGE-SIDE ENGAGEMENT**

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(73) Assignee: **Dan Raz Ltd.**, Tirat Carmel (IL)

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(51) **Int. Cl.**

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E06B 3/76	(2006.01)
E06B 3/72	(2006.01)
E06B 7/36	(2006.01)

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CPC ***E06B 5/113*** (2013.01); *E06B 3/72* (2013.01); *E06B 3/76* (2013.01); *E06B 7/367* (2013.01); *E06B 2003/7074* (2013.01)

(58) **Field of Classification Search**
CPC E06B 3/88; E06B 5/113
See application file for complete search history.

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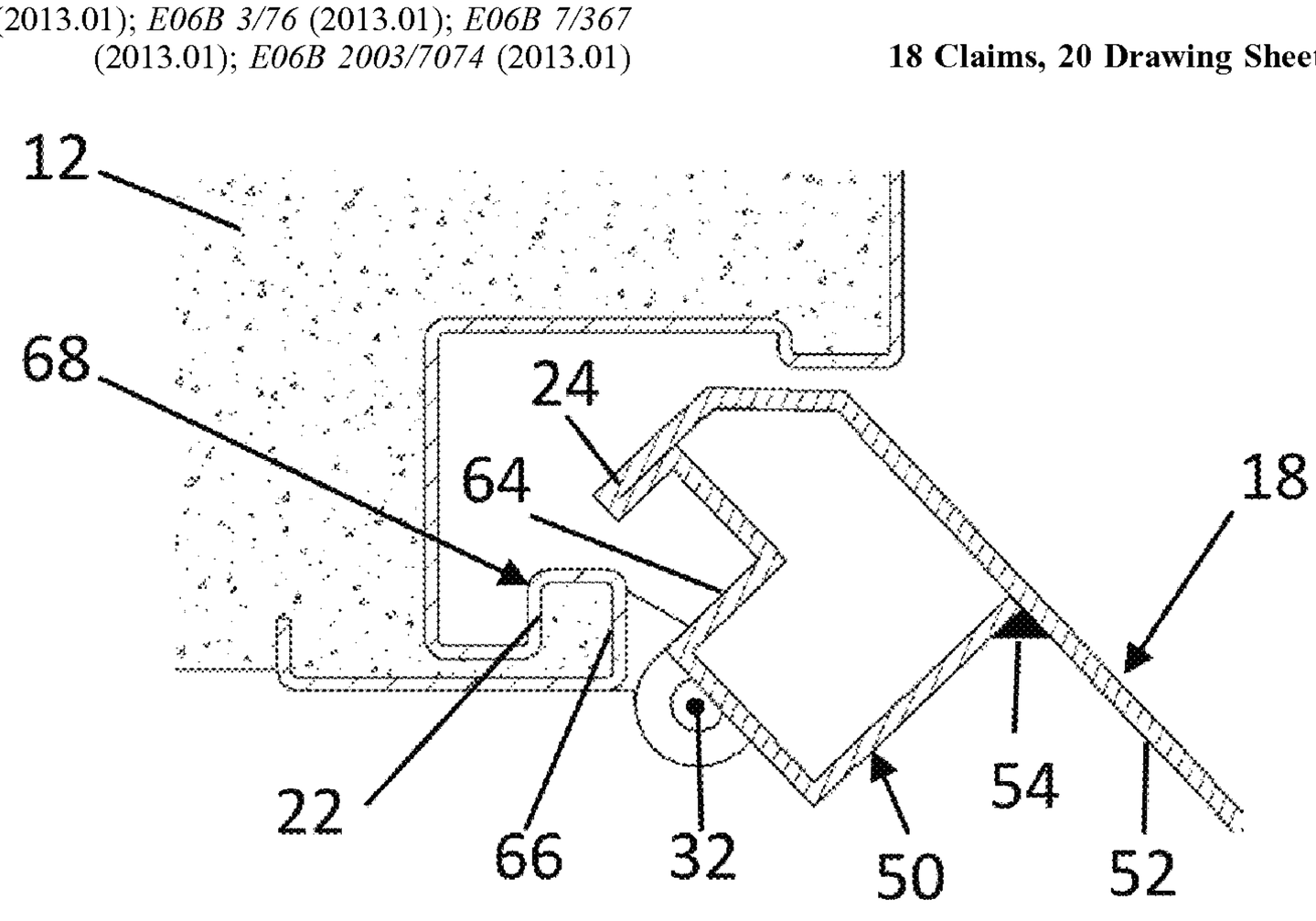
(57) **ABSTRACT**

A door or window assembly includes an opening bounded by a frame including a hinge jamb (**12**). A panel (**18**) is hung relative to the hinge jamb via a hinge arrangement (**20**) so as to swing between an open position and a closed position. An engagement configuration includes a ledge (**22**) located in fixed relation to the hinge jamb, and a flange (**24**) rigidly associated with the panel. The engagement configuration allows me panel to swing freely between open and closed positions. In the closed position, the flange (**24**) is brought into facing relation with the ledge (**22**) such that force directed to displace the panel (**18**) within the plane of closure away from the hinge jamb (**12**) acts to bring the flange into engagement with the ledge.

18 Claims, 20 Drawing Sheets



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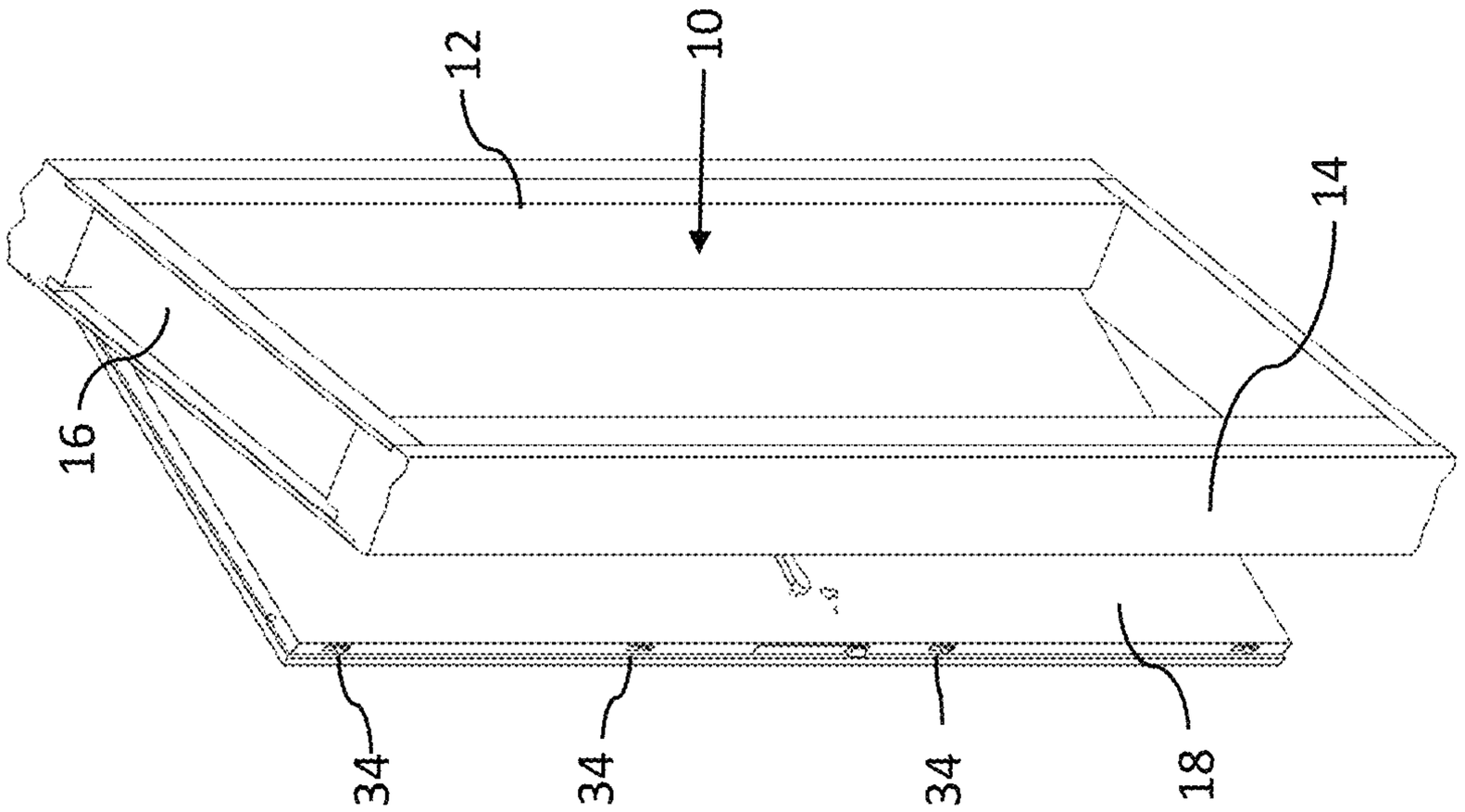


FIG. 2

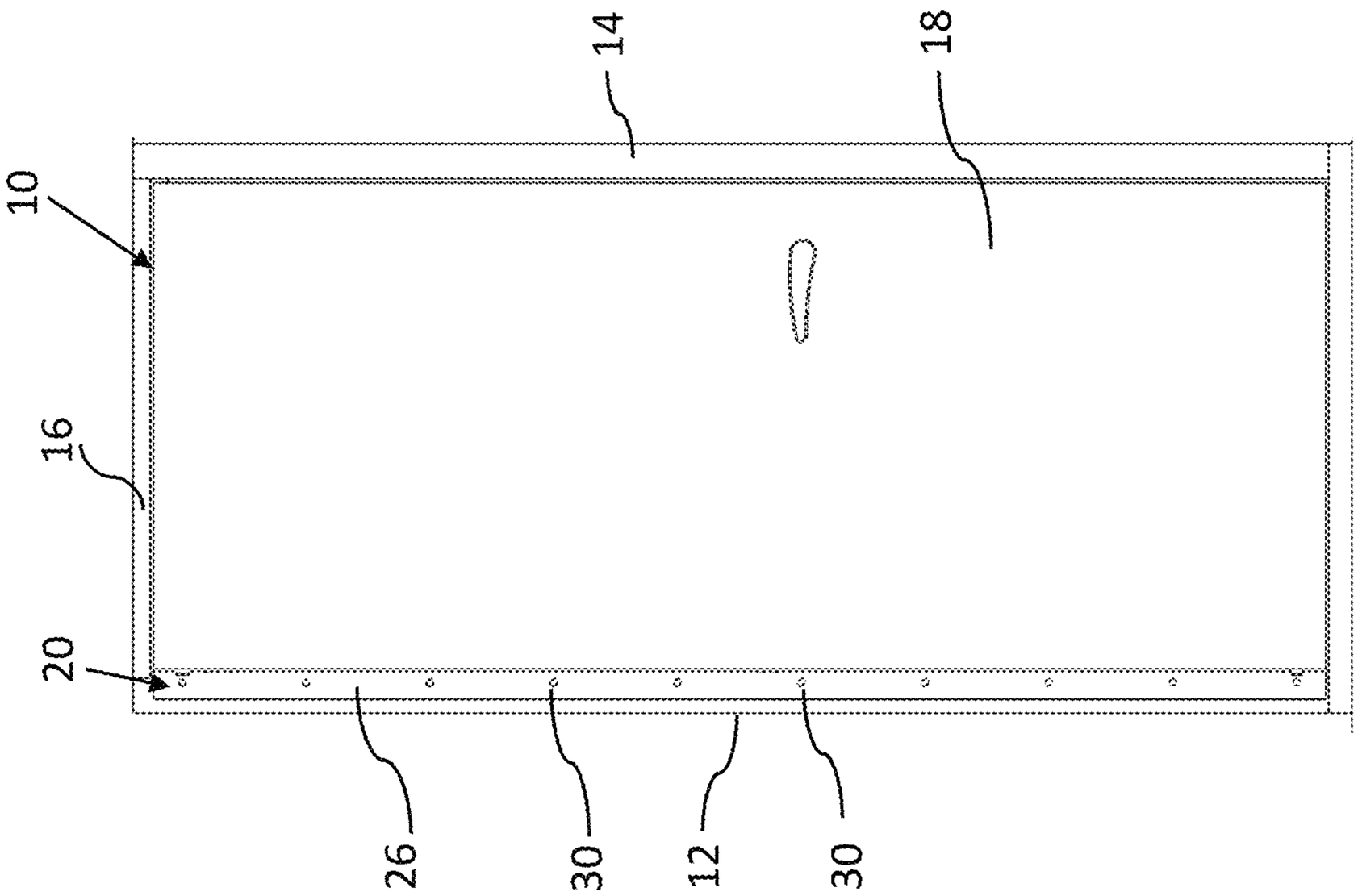


FIG. 1

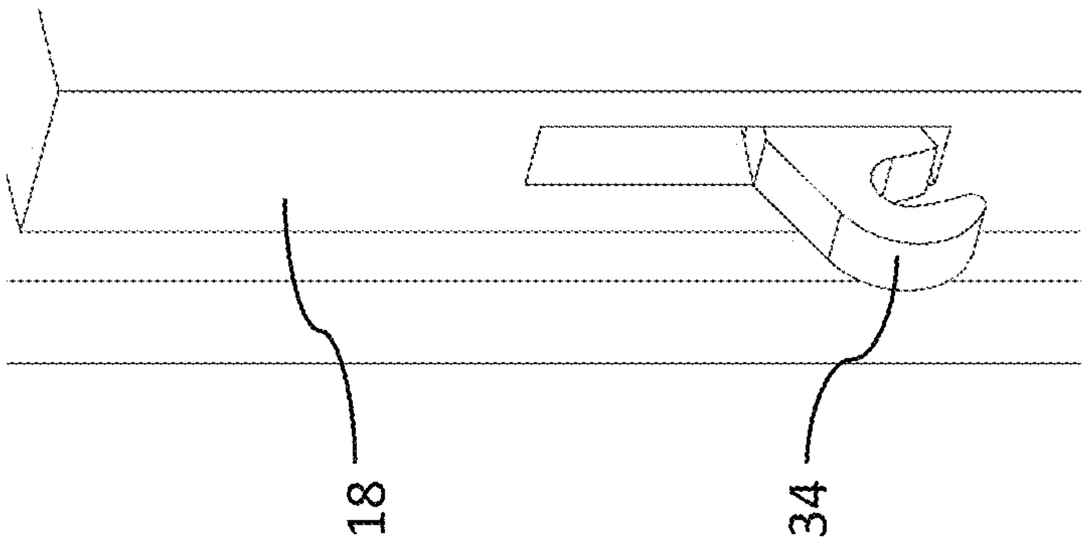


FIG. 3B

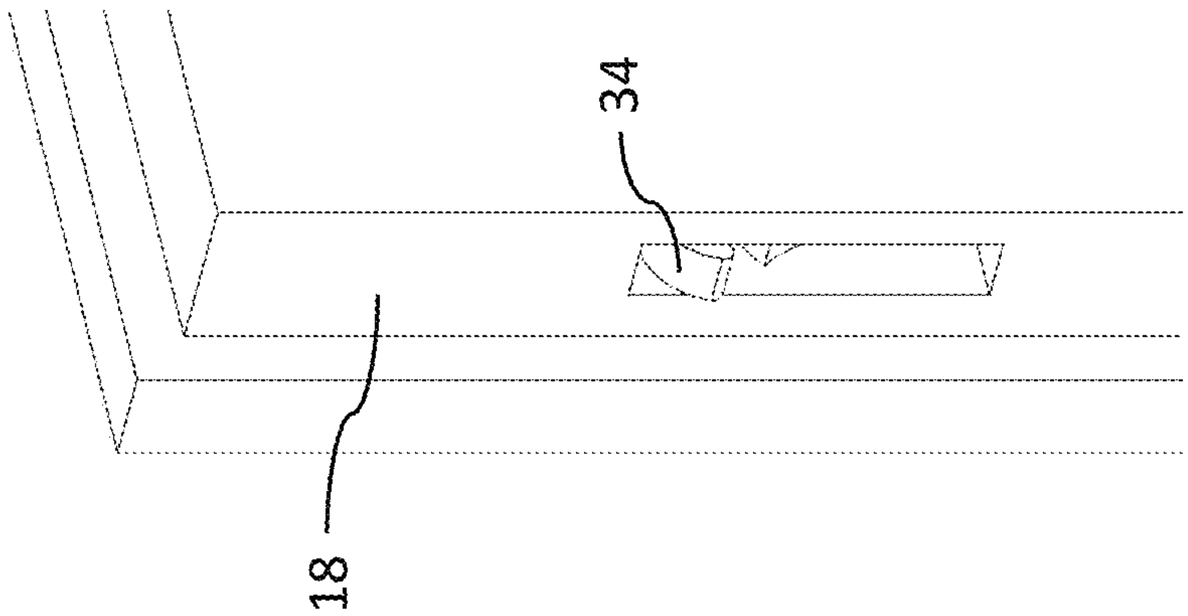


FIG. 3A

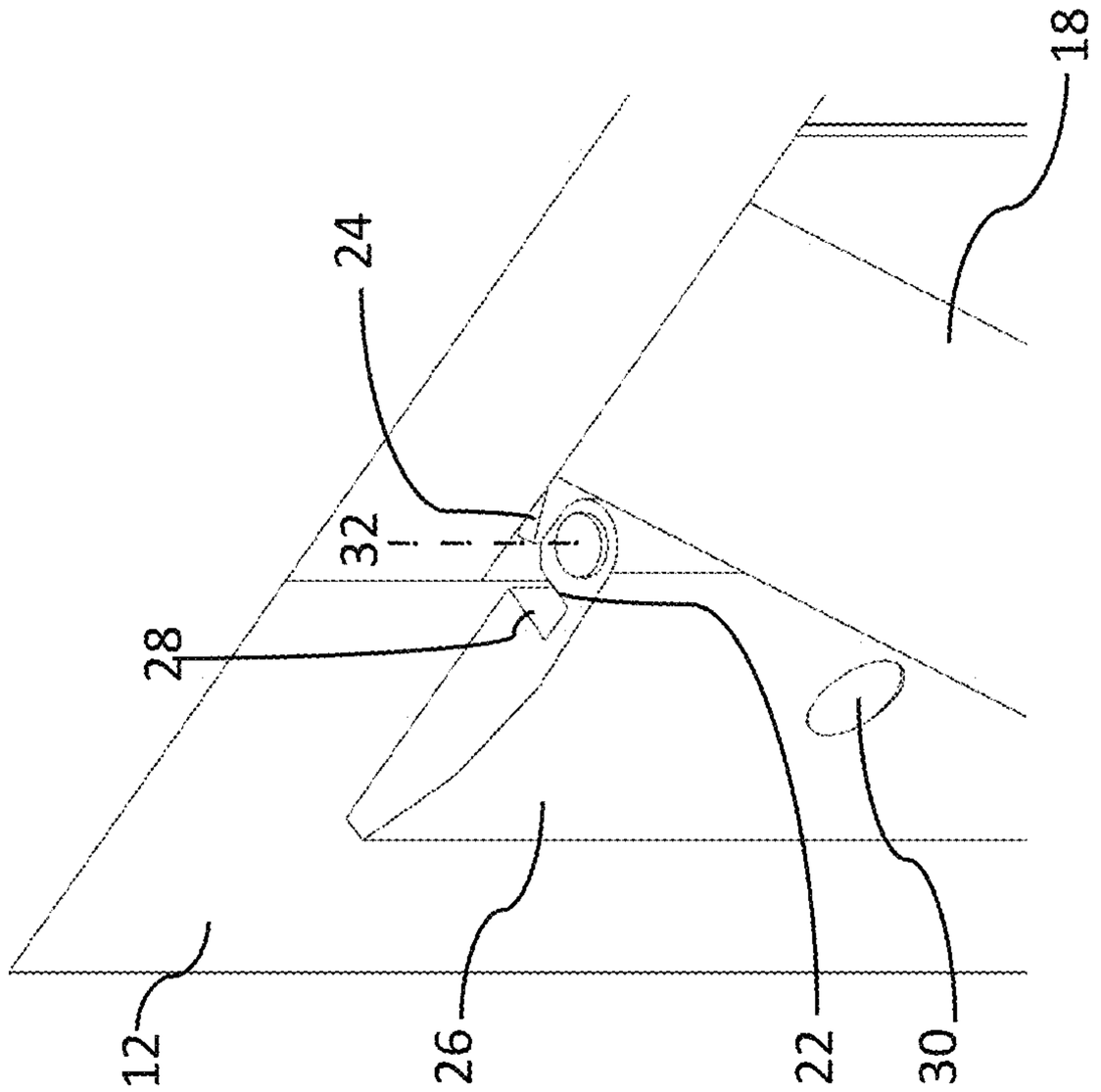


FIG. 4B

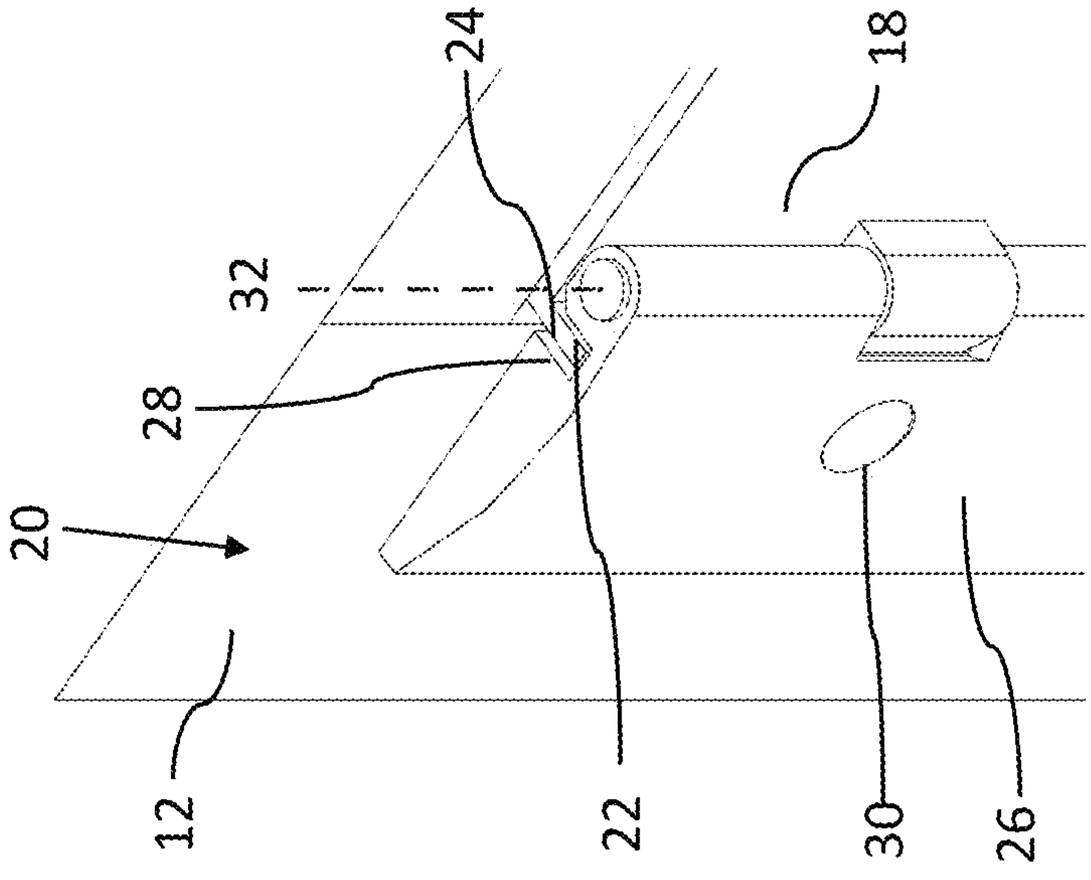


FIG. 4A

FIG. 5E

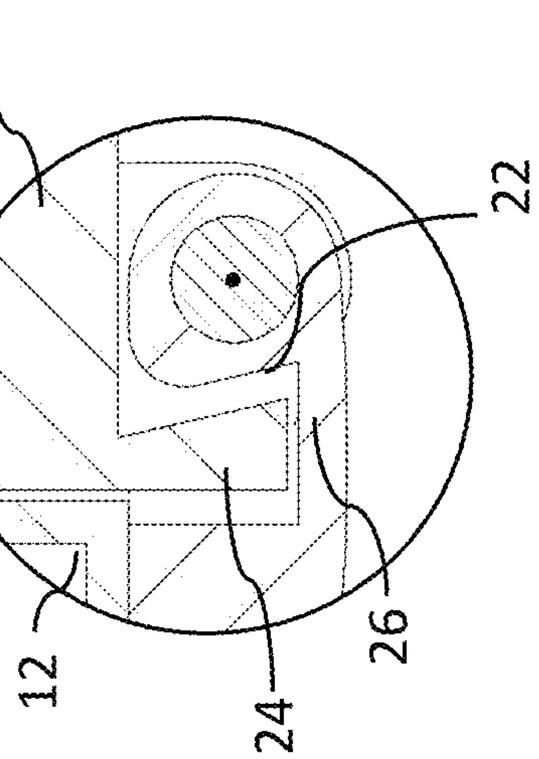


FIG. 5F

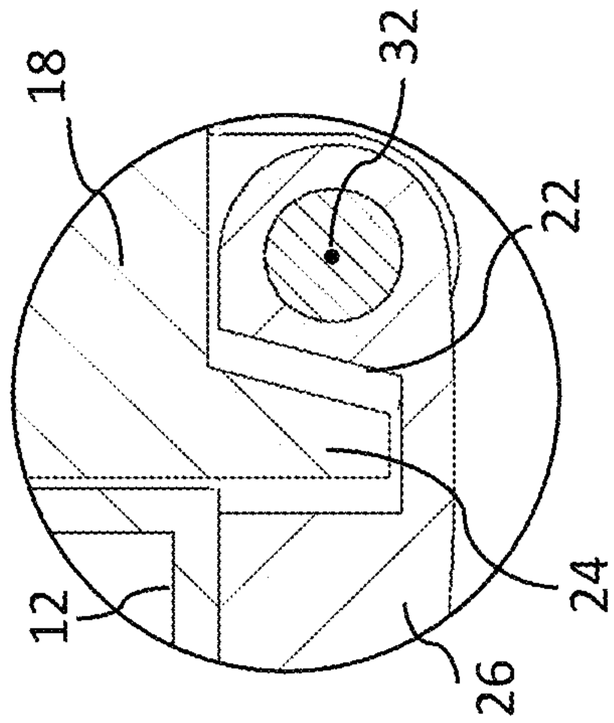
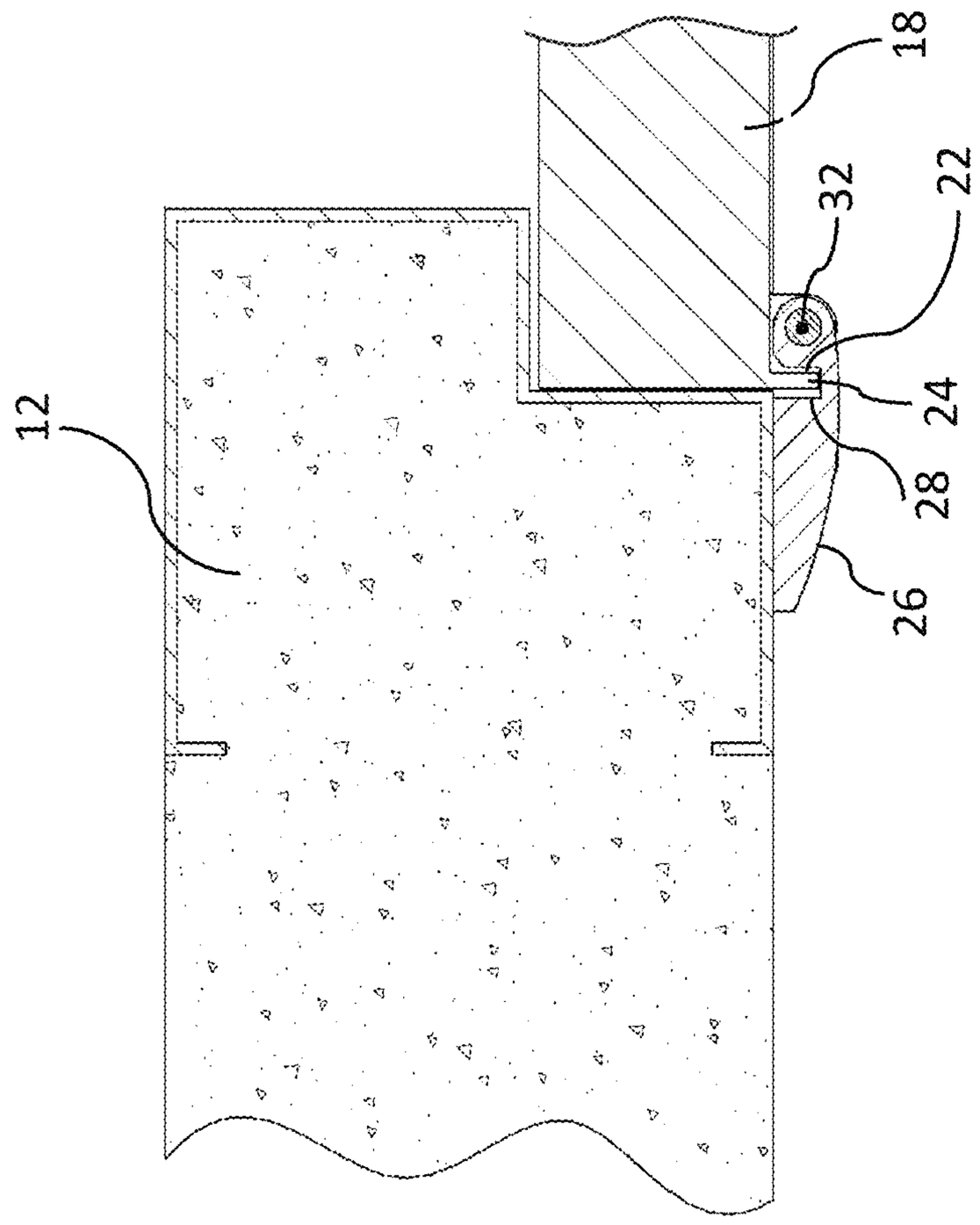


FIG. 5A



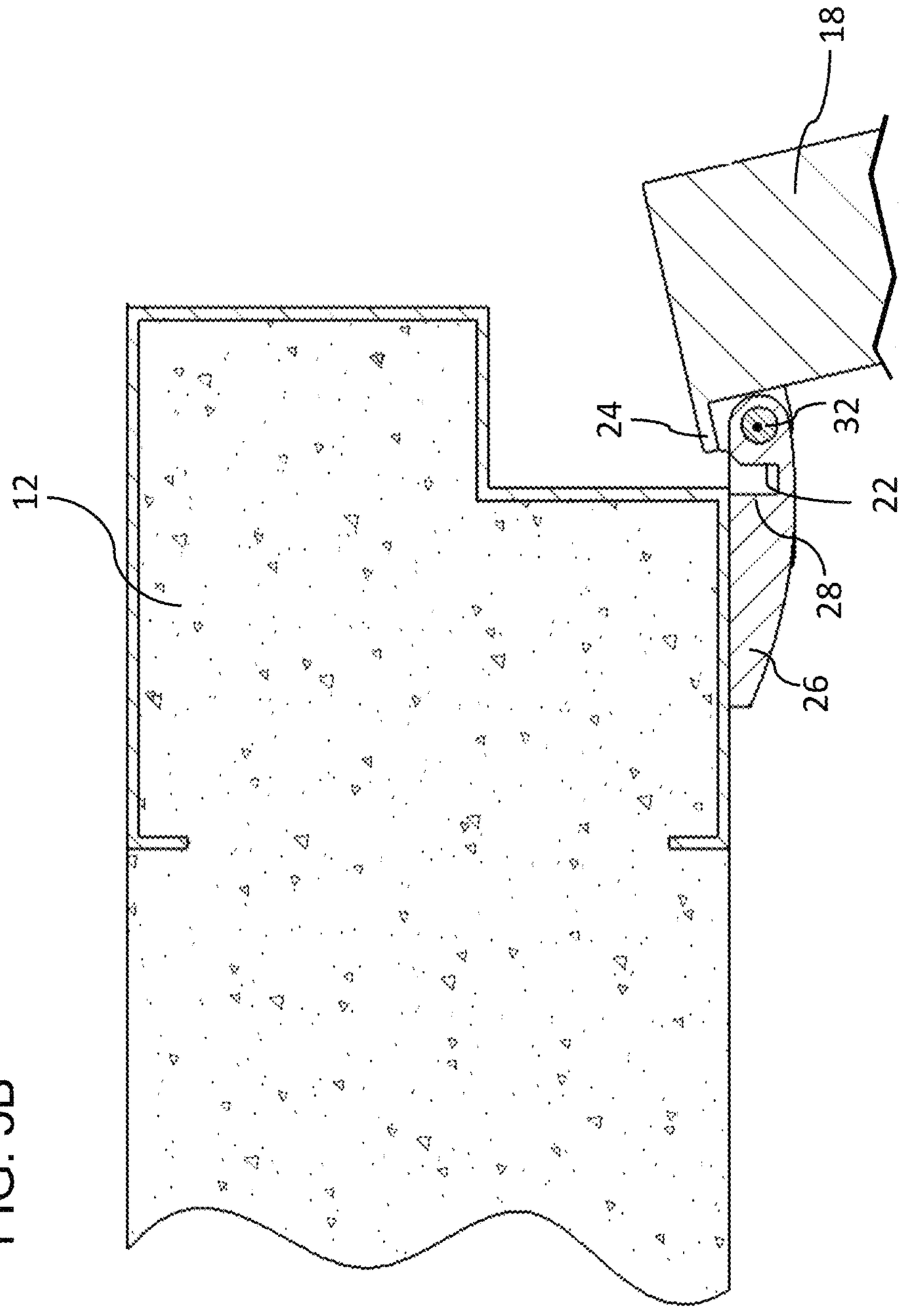


FIG. 5B

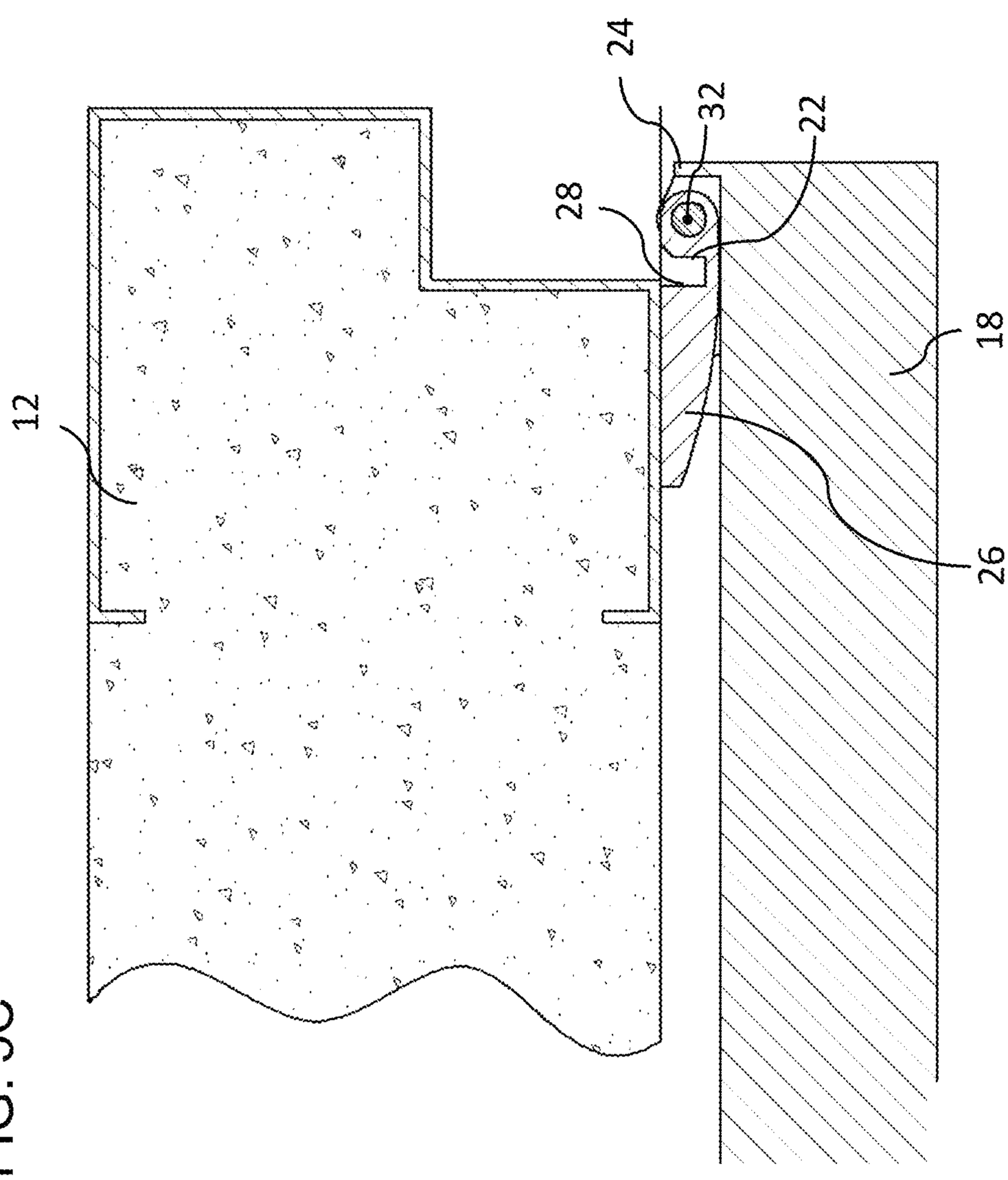


FIG. 5C

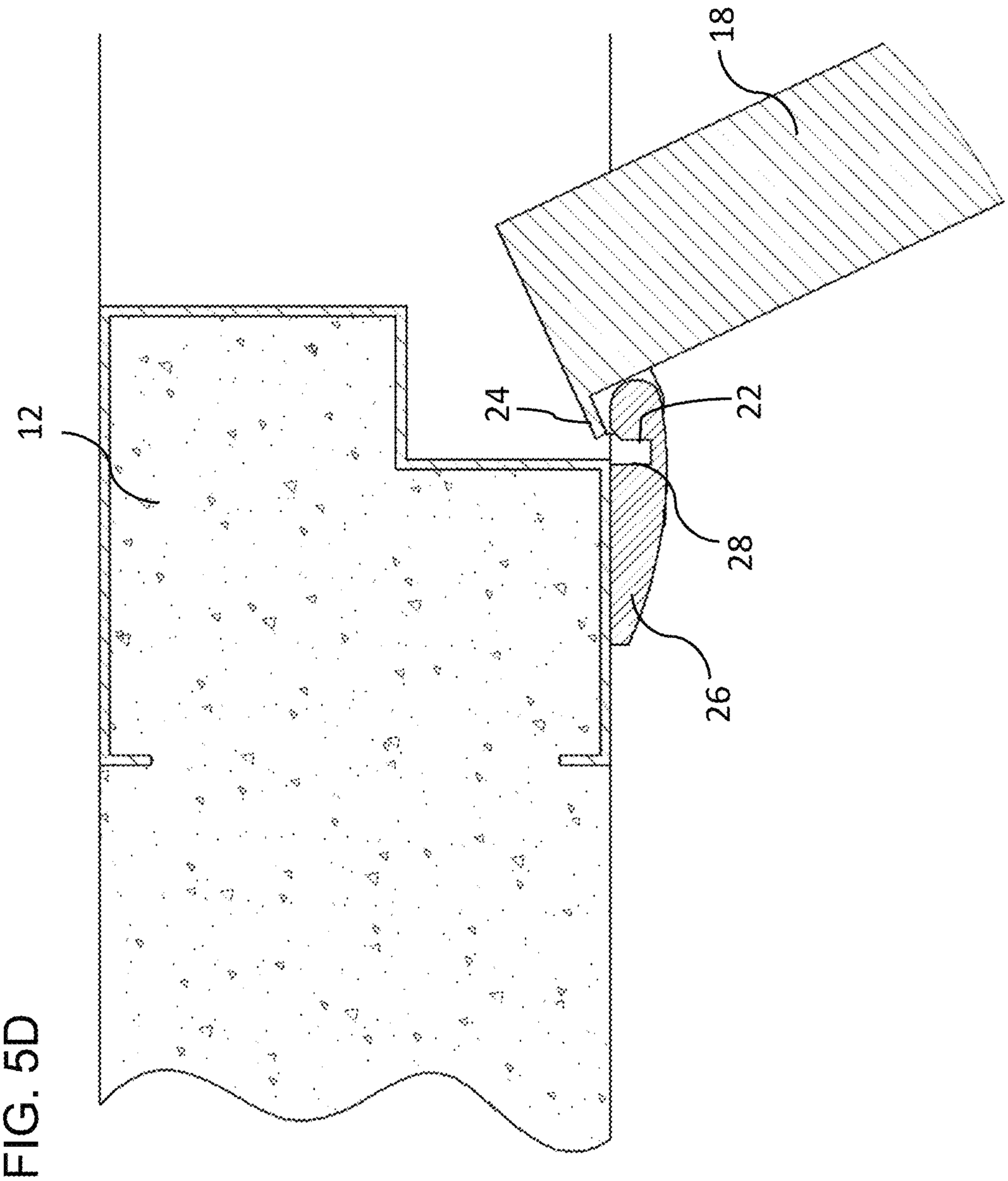


FIG. 5D

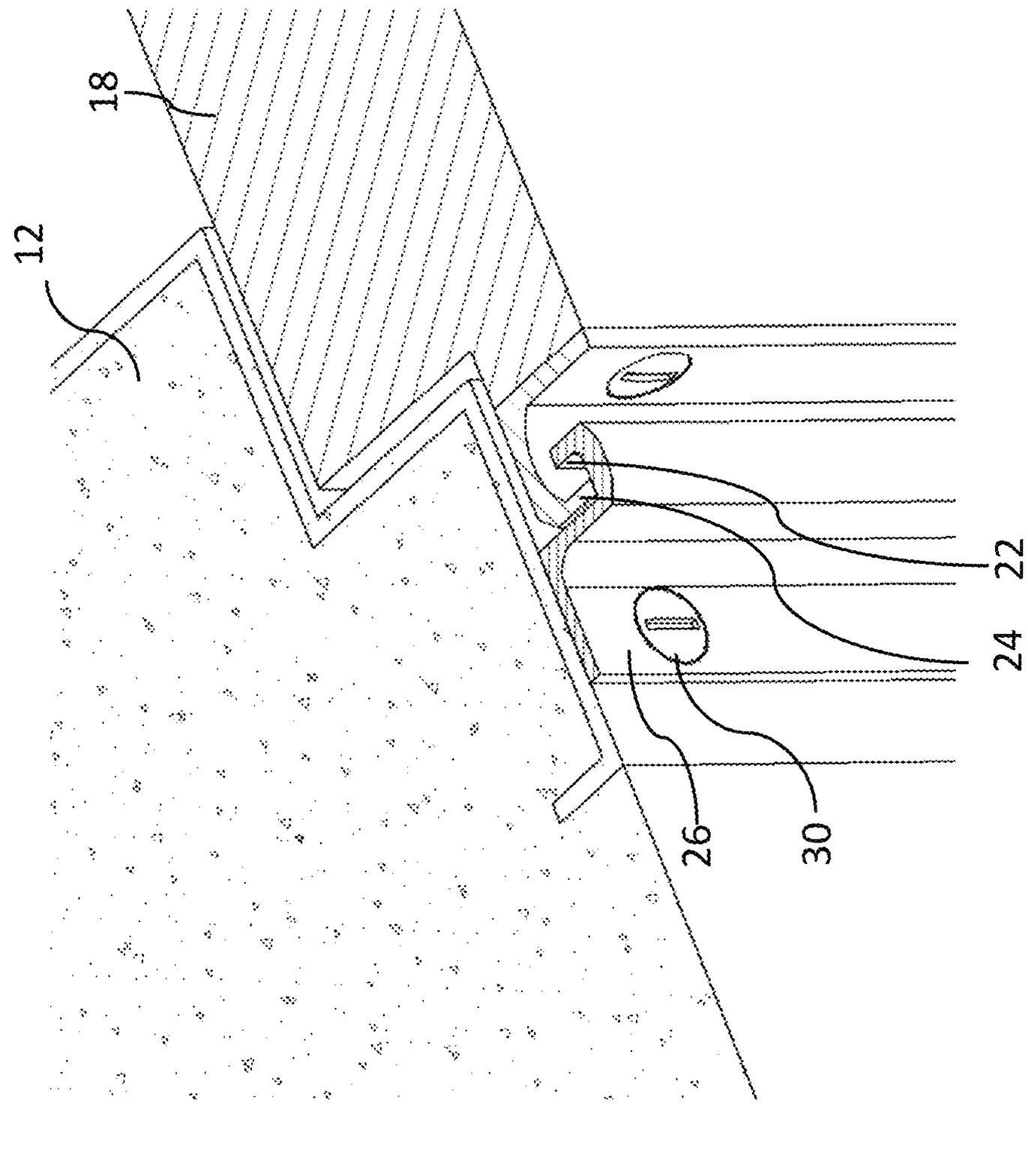


FIG. 6

FIG. 7B

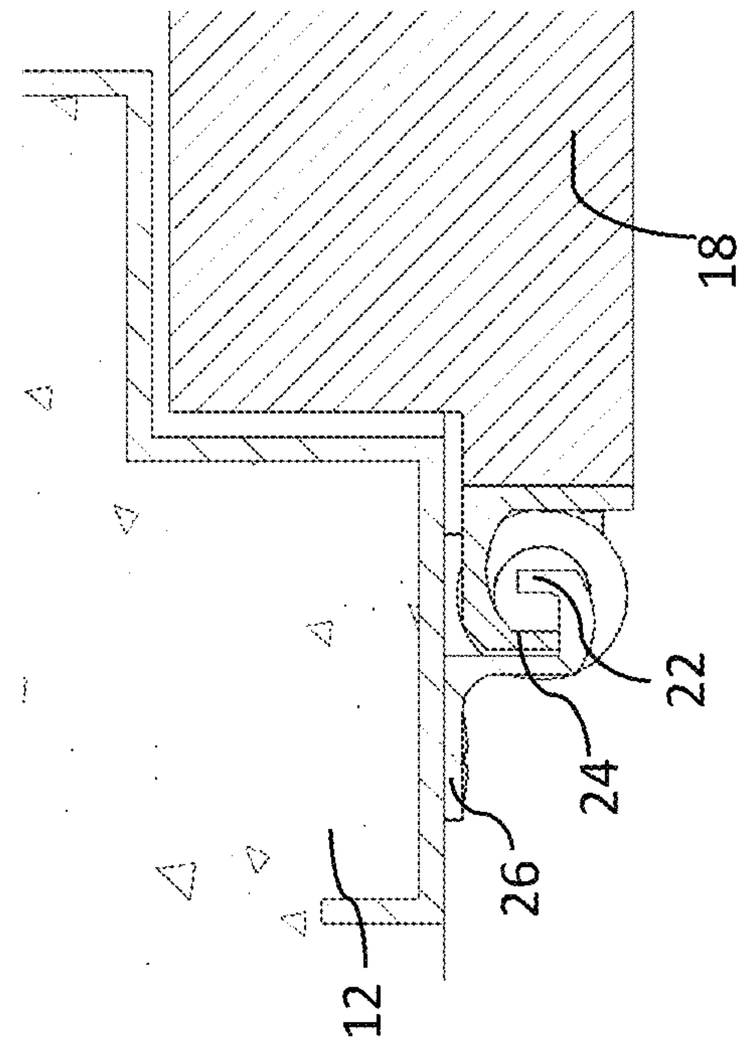
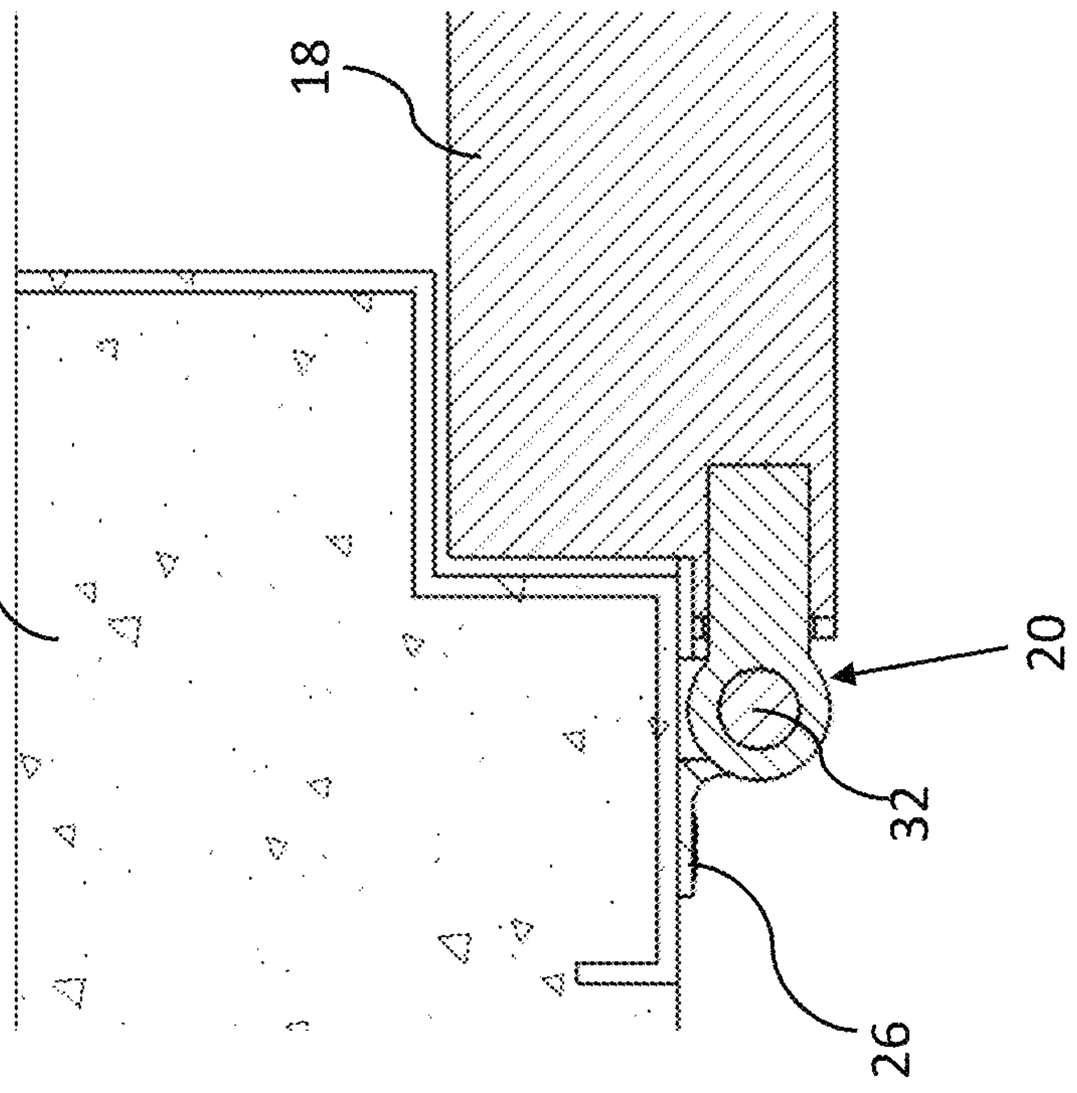


FIG. 7A



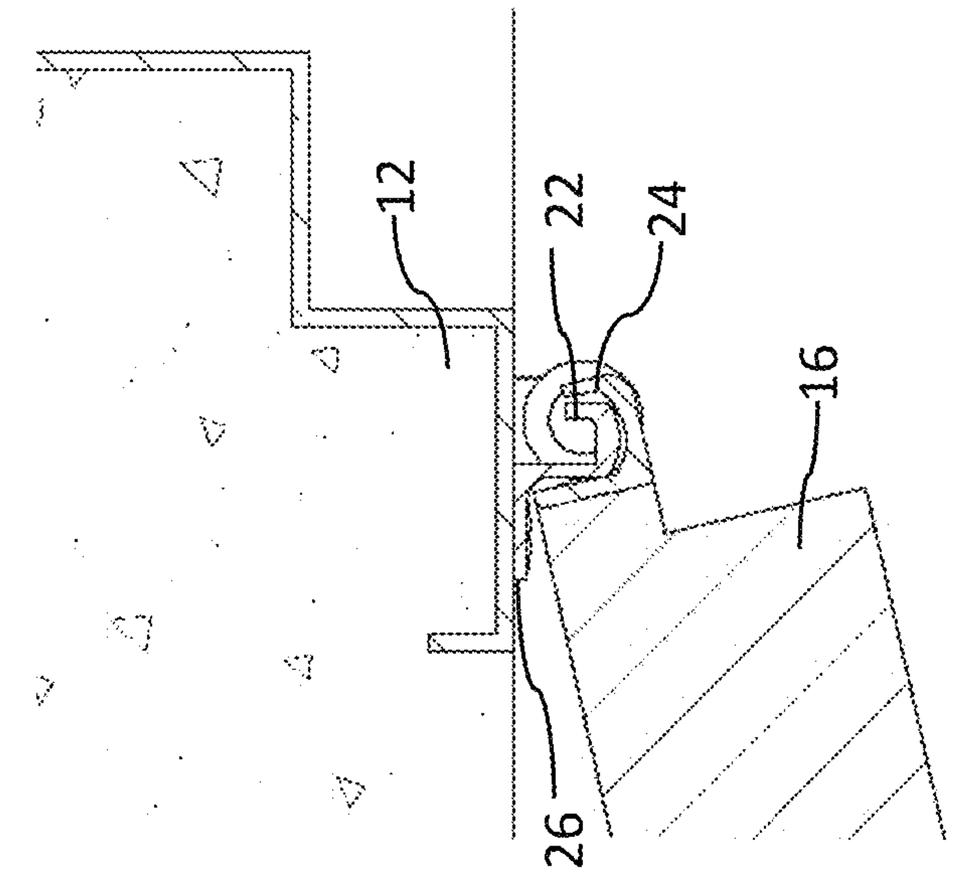


FIG. 7D

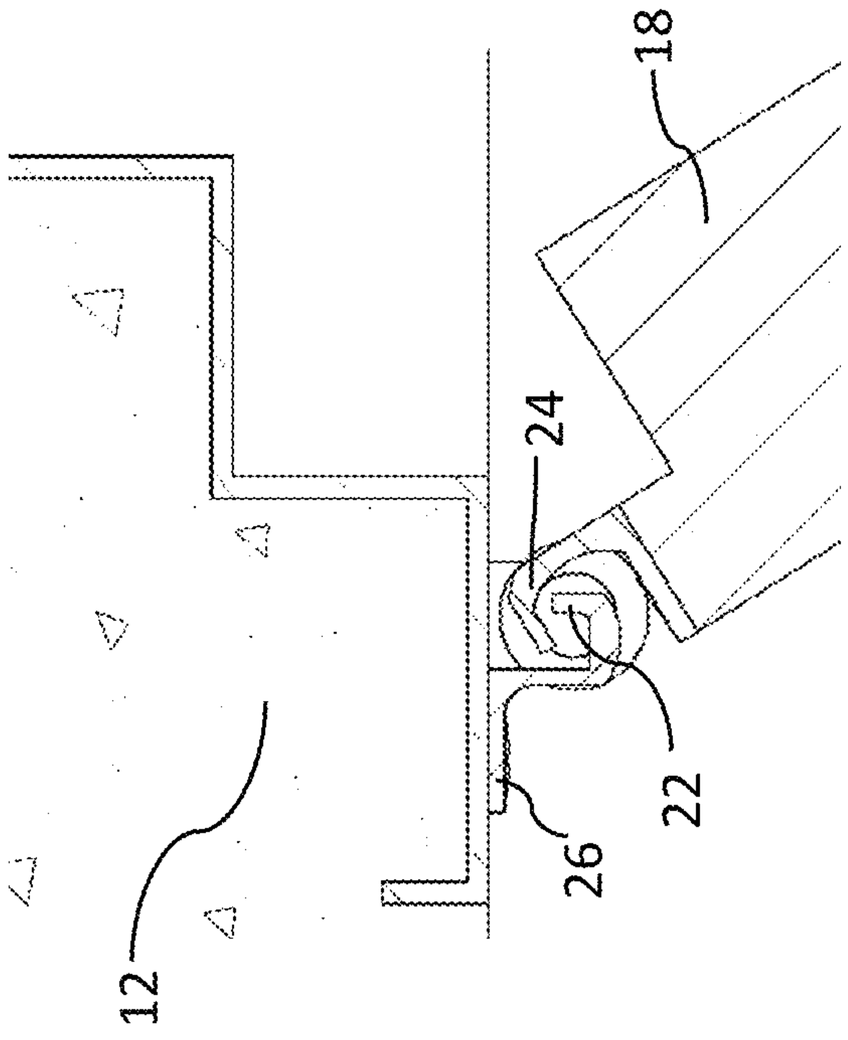


FIG. 7C

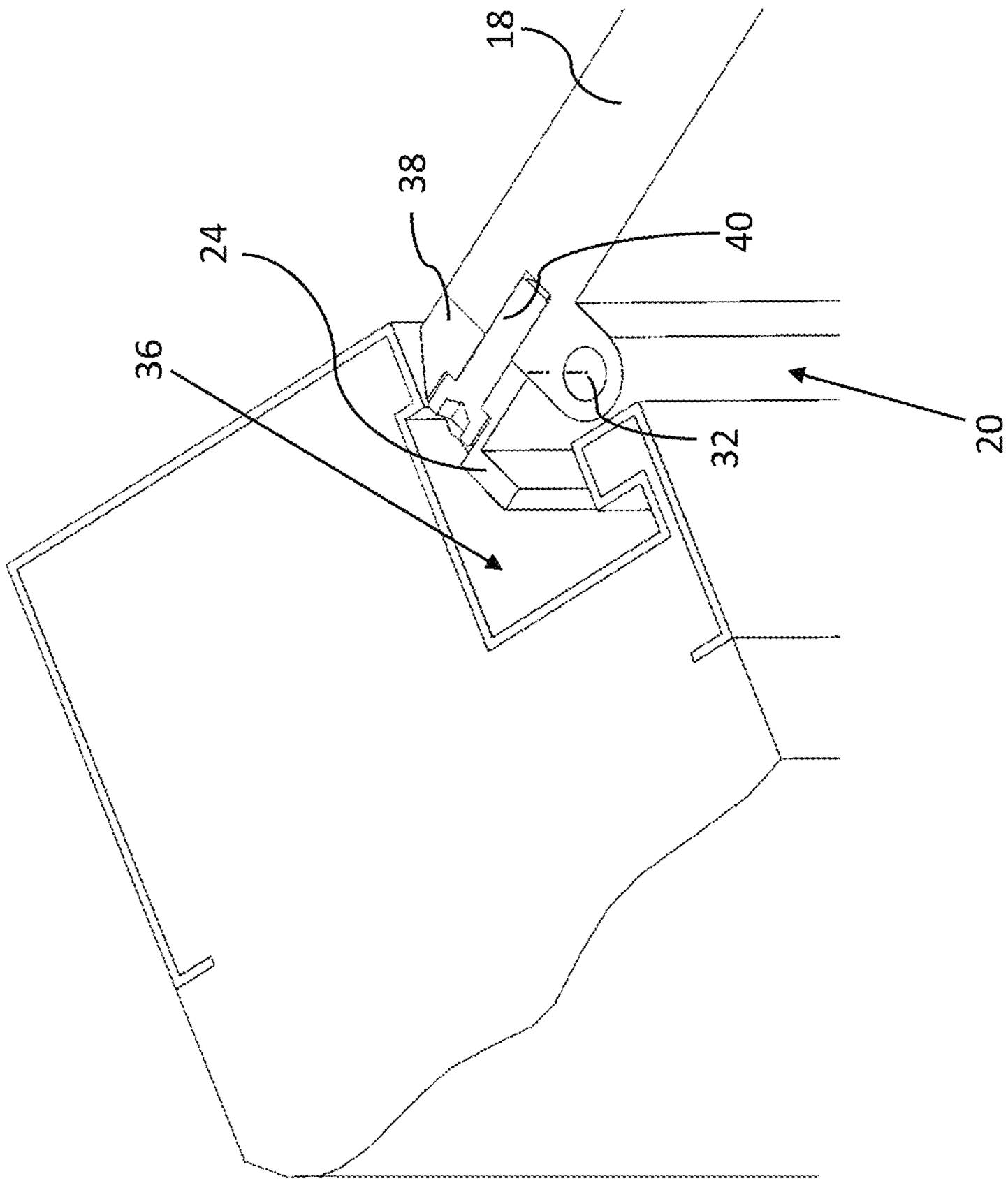


FIG. 8

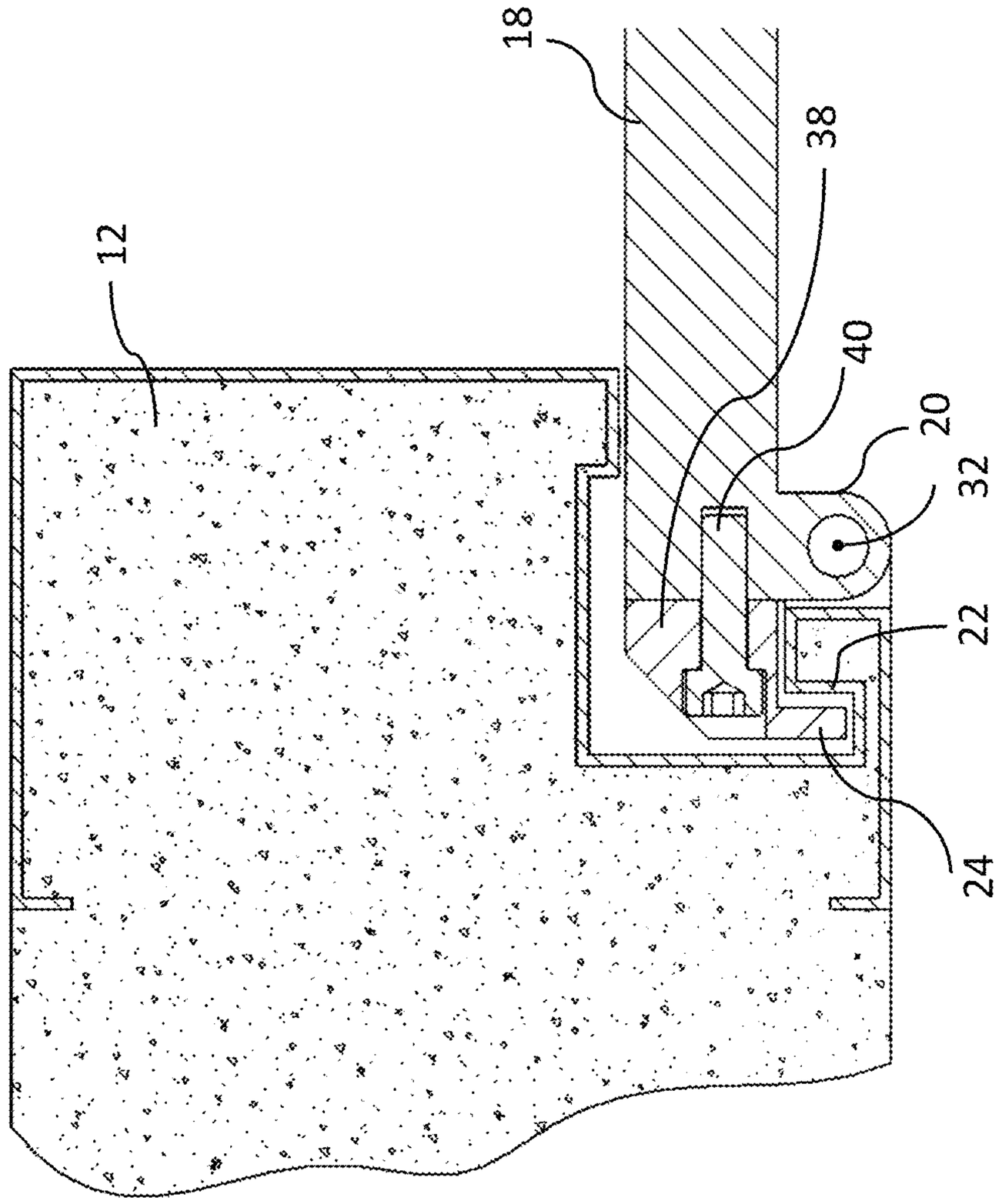


FIG. 9A

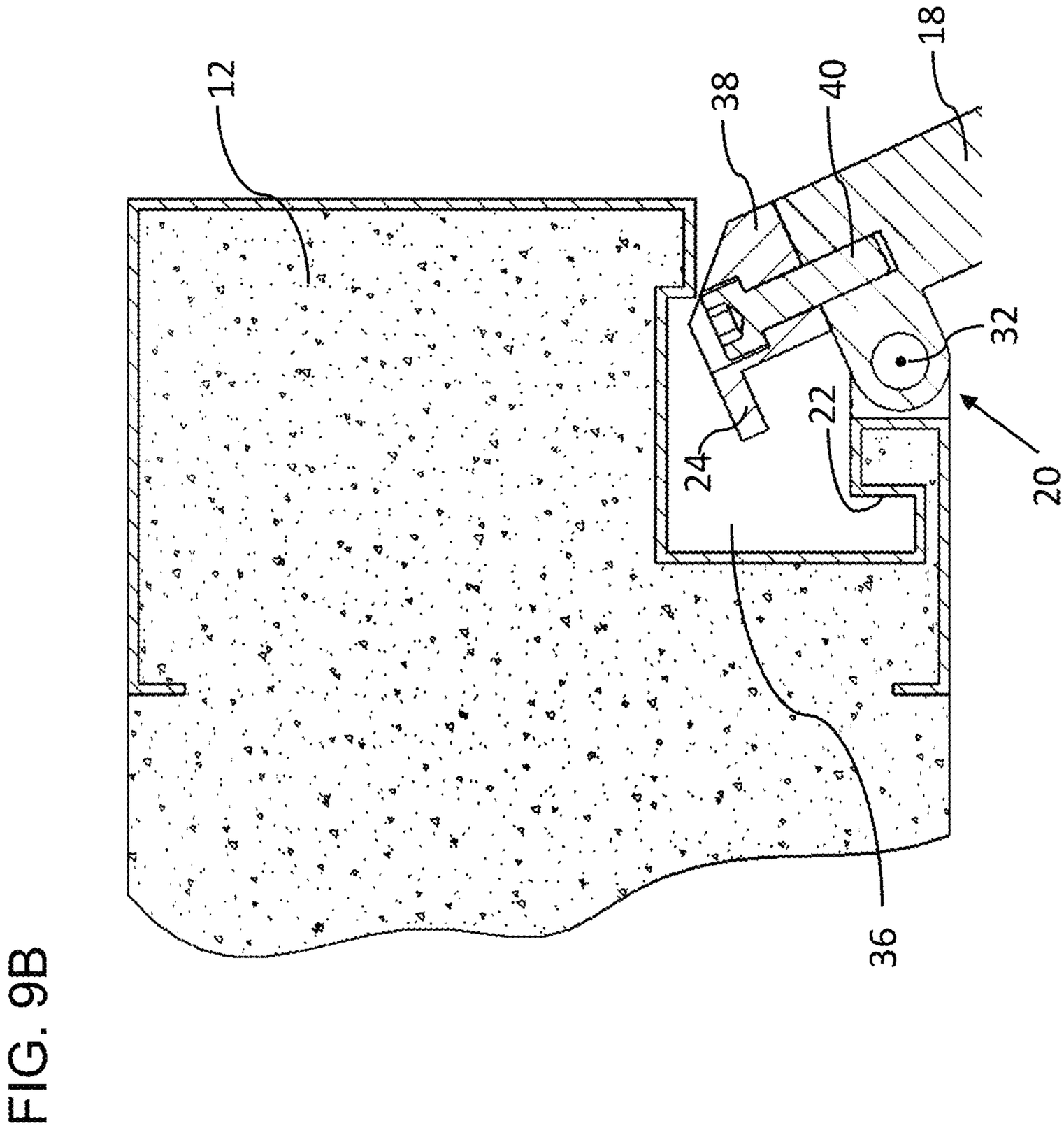


FIG. 9B

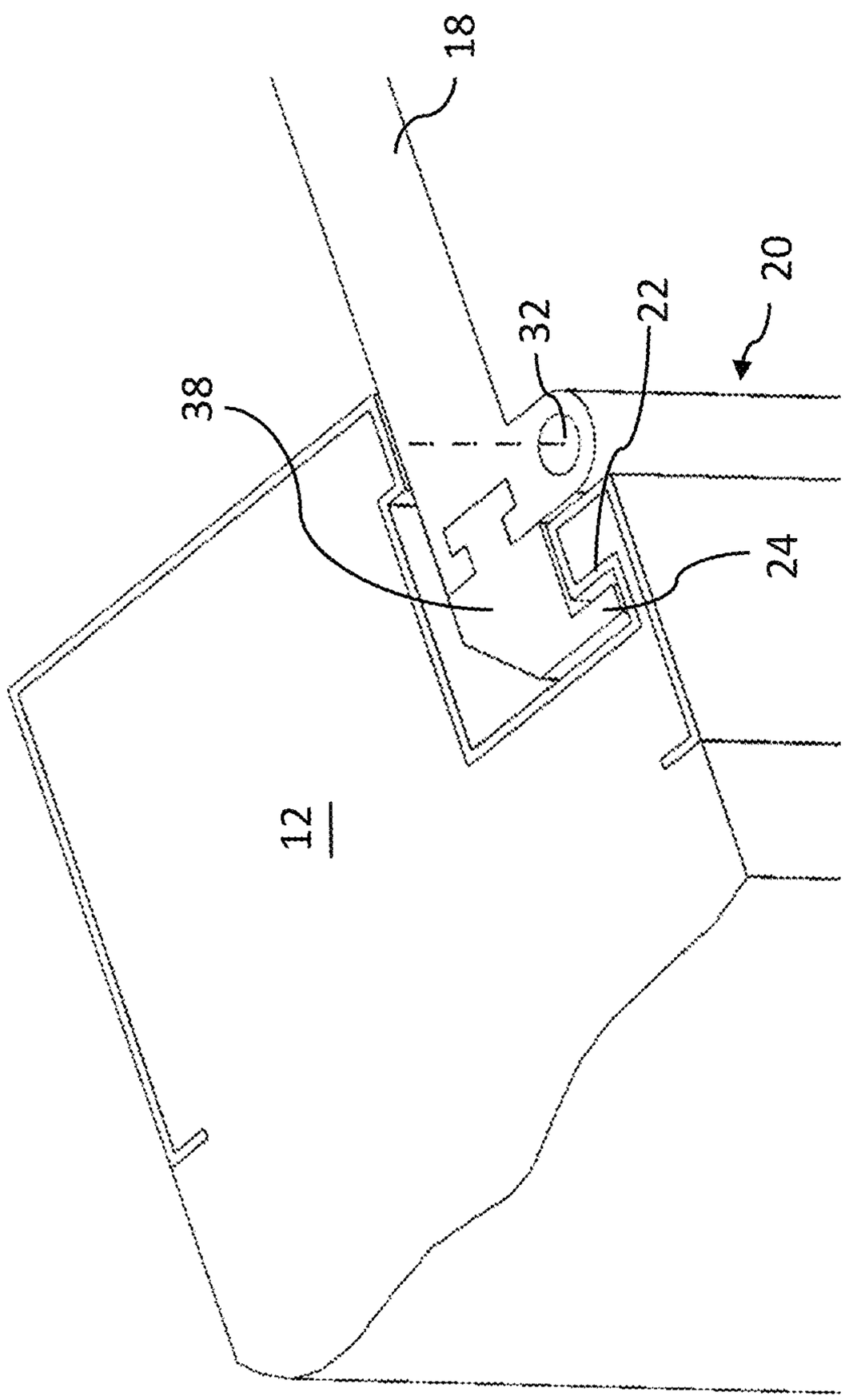


FIG. 10

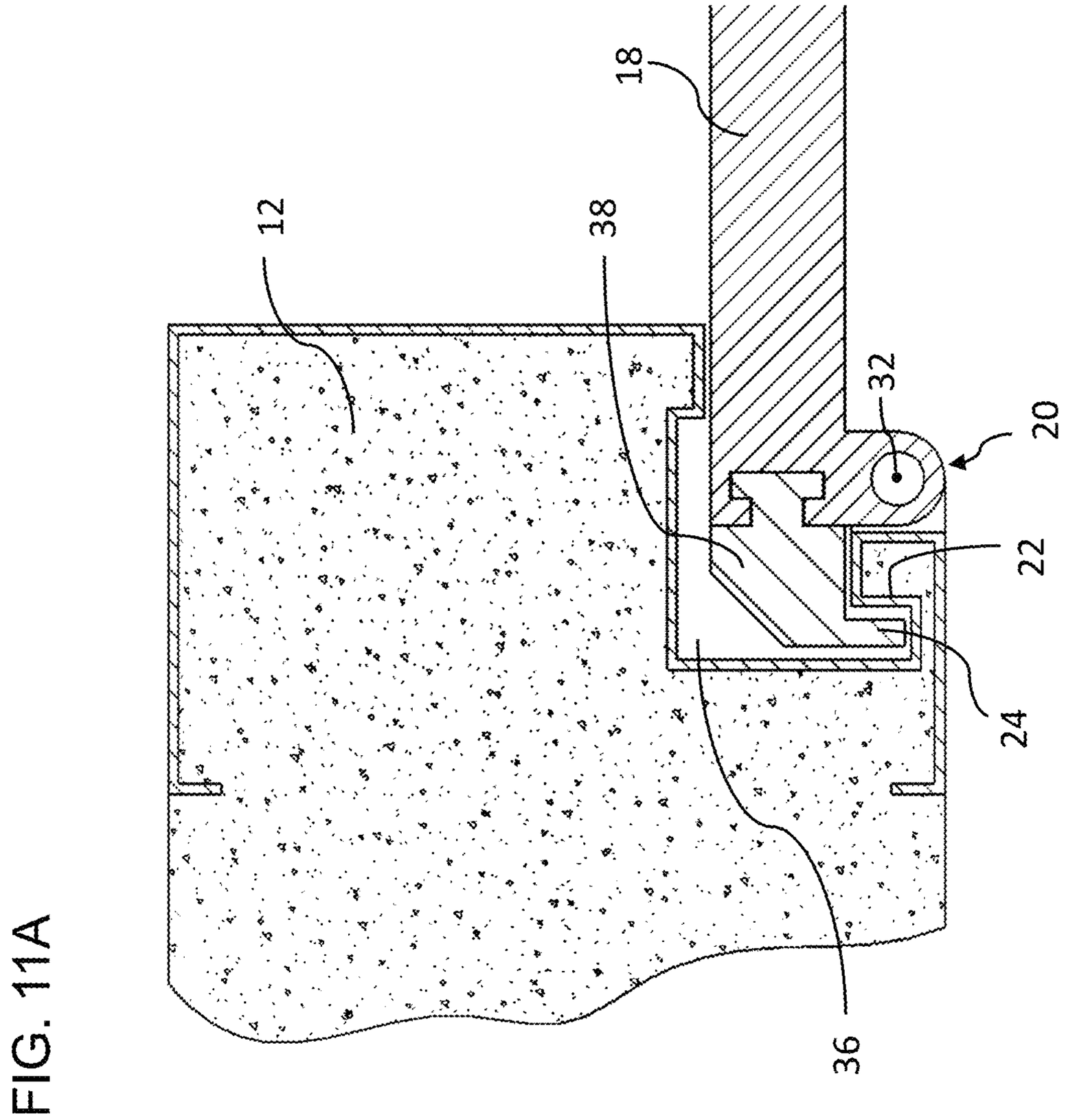


FIG. 11A

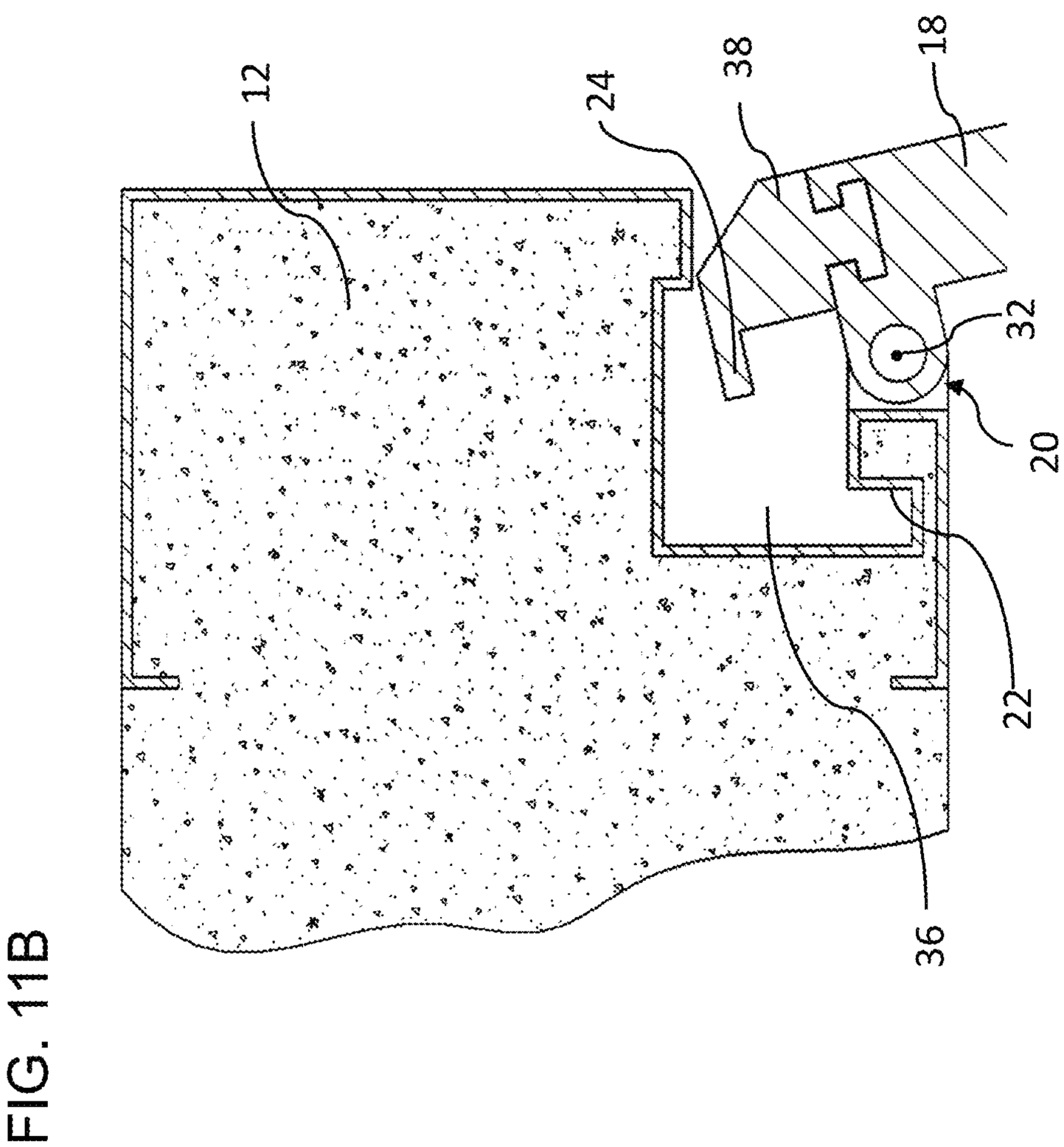


FIG. 11B

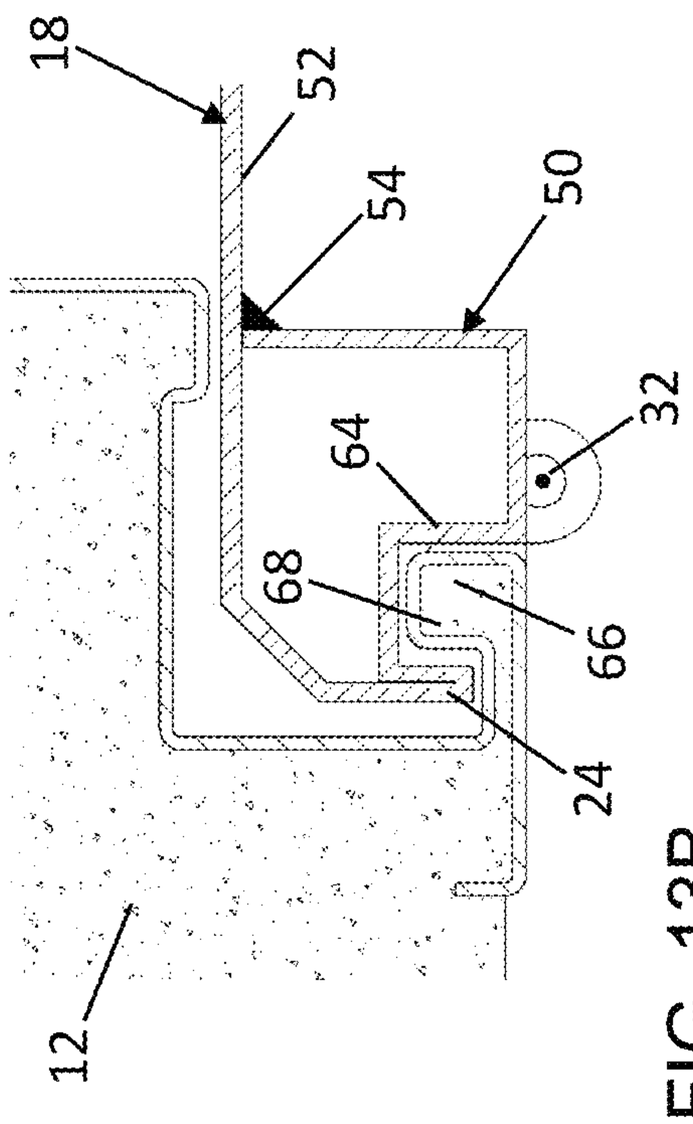


FIG. 13A

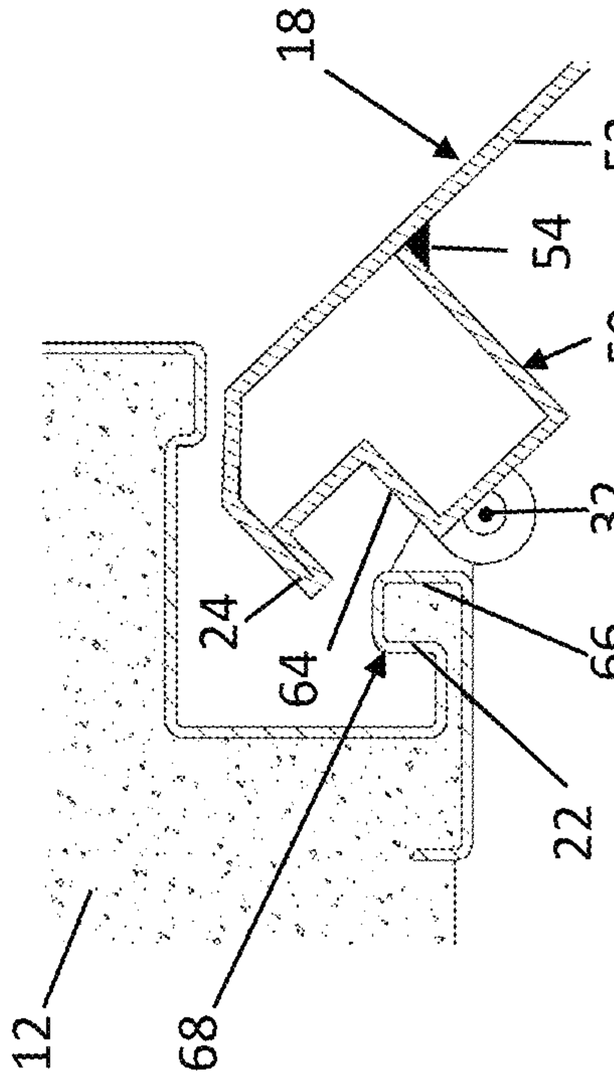


FIG. 13B

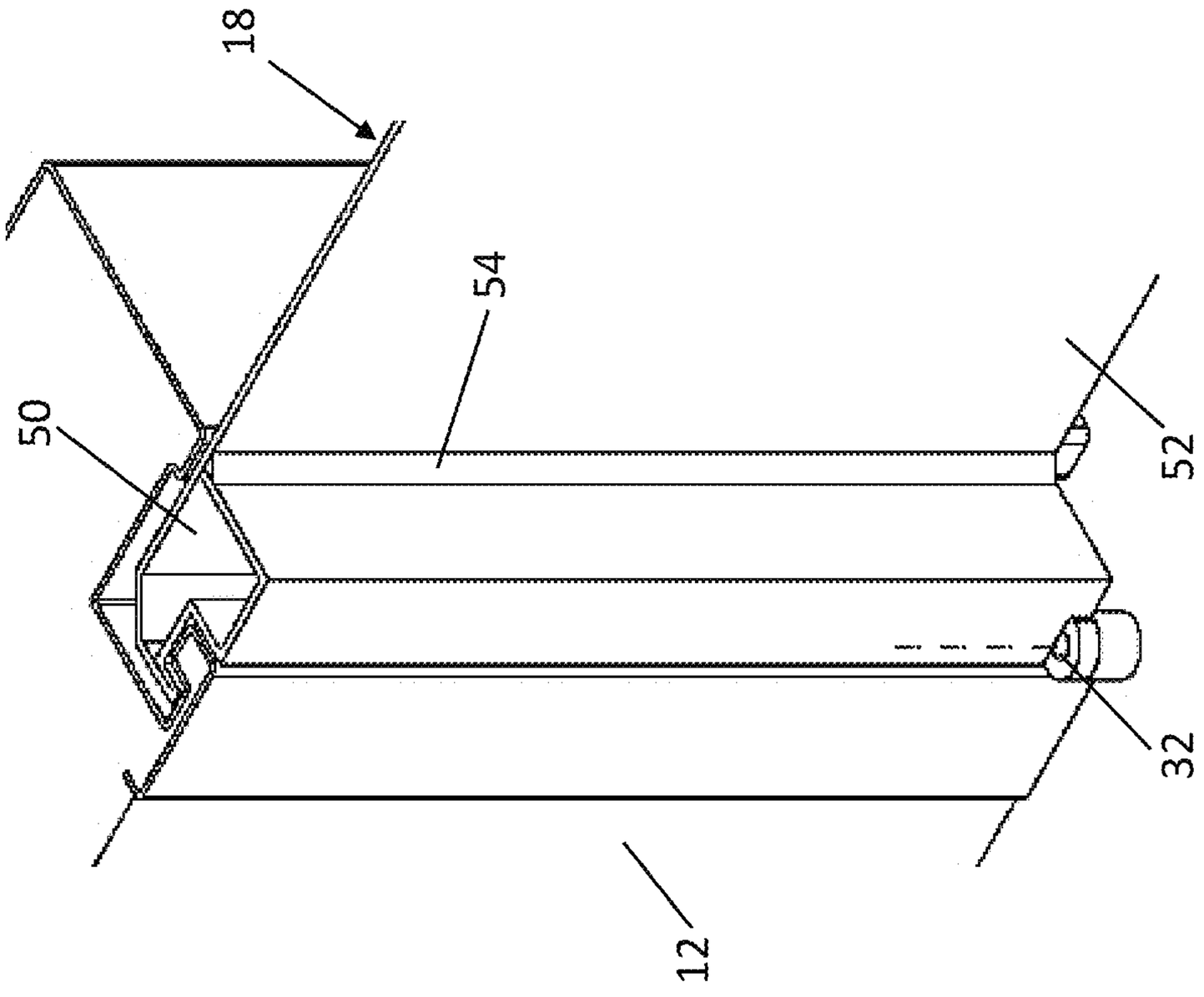


FIG. 12

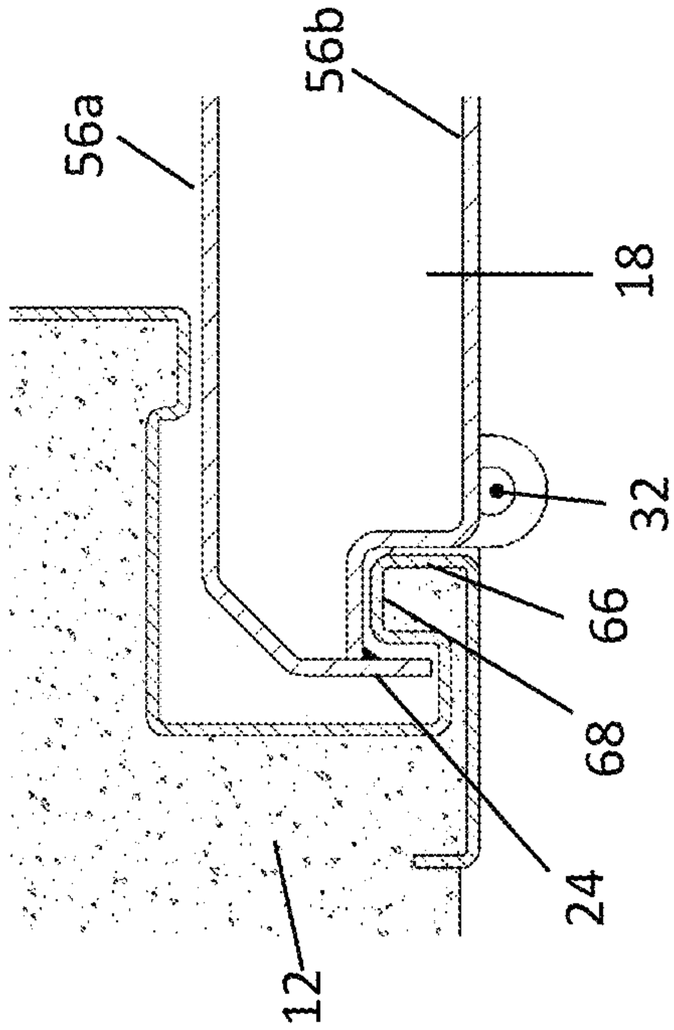


FIG. 15A

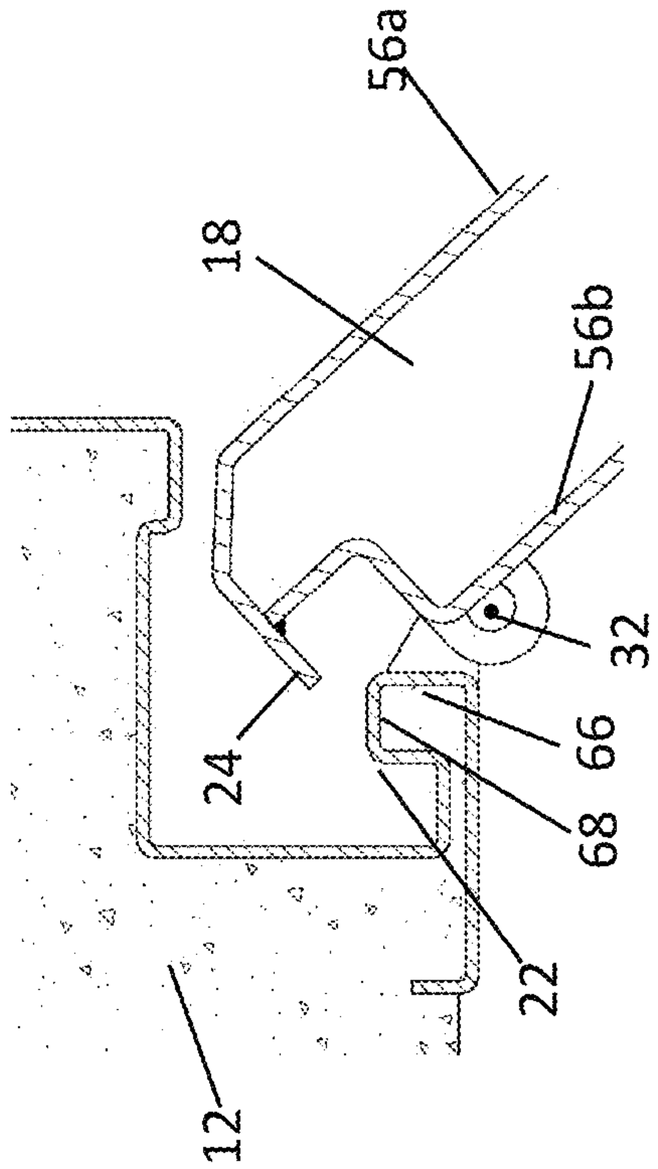


FIG. 15B

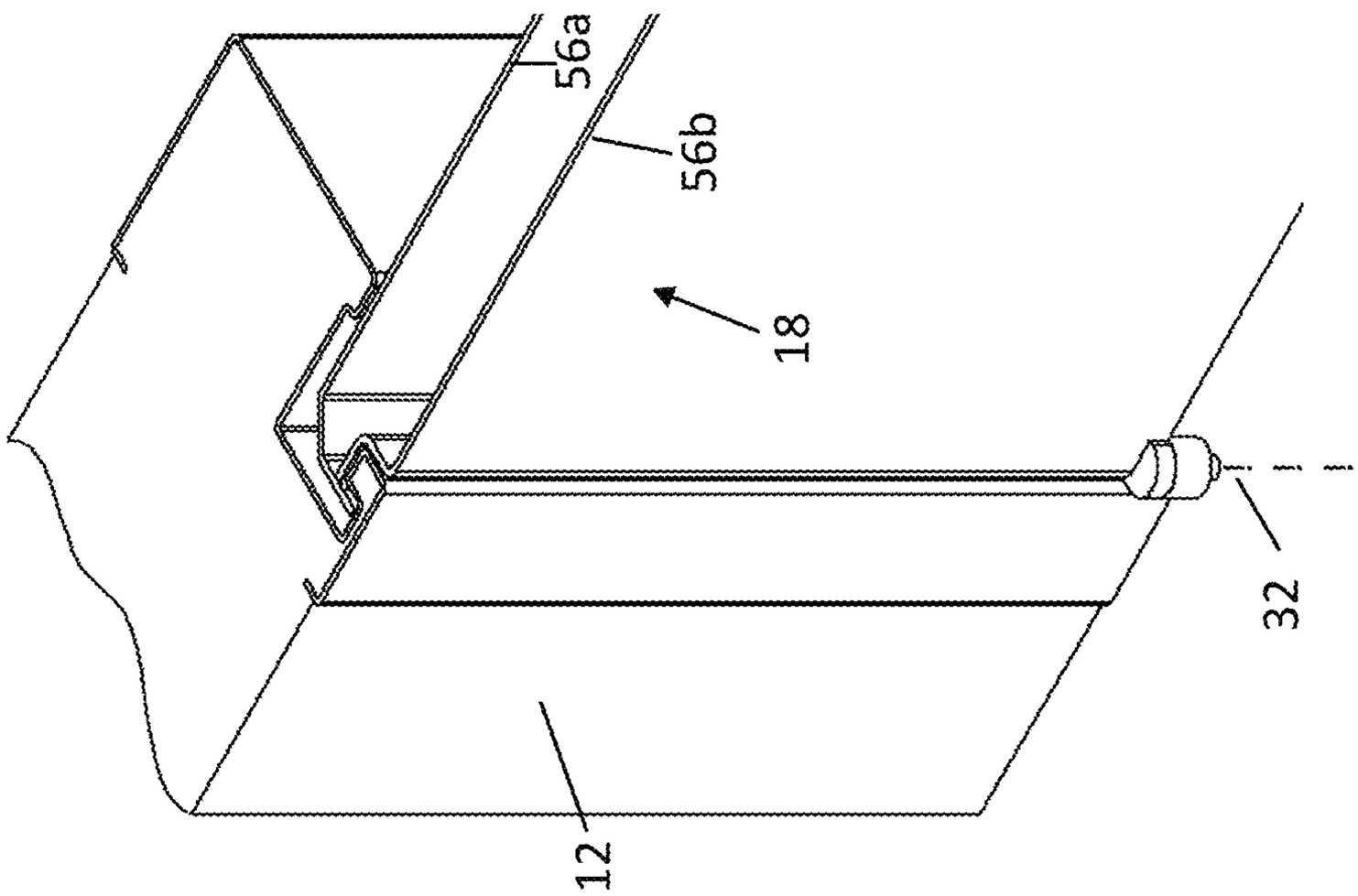


FIG. 14

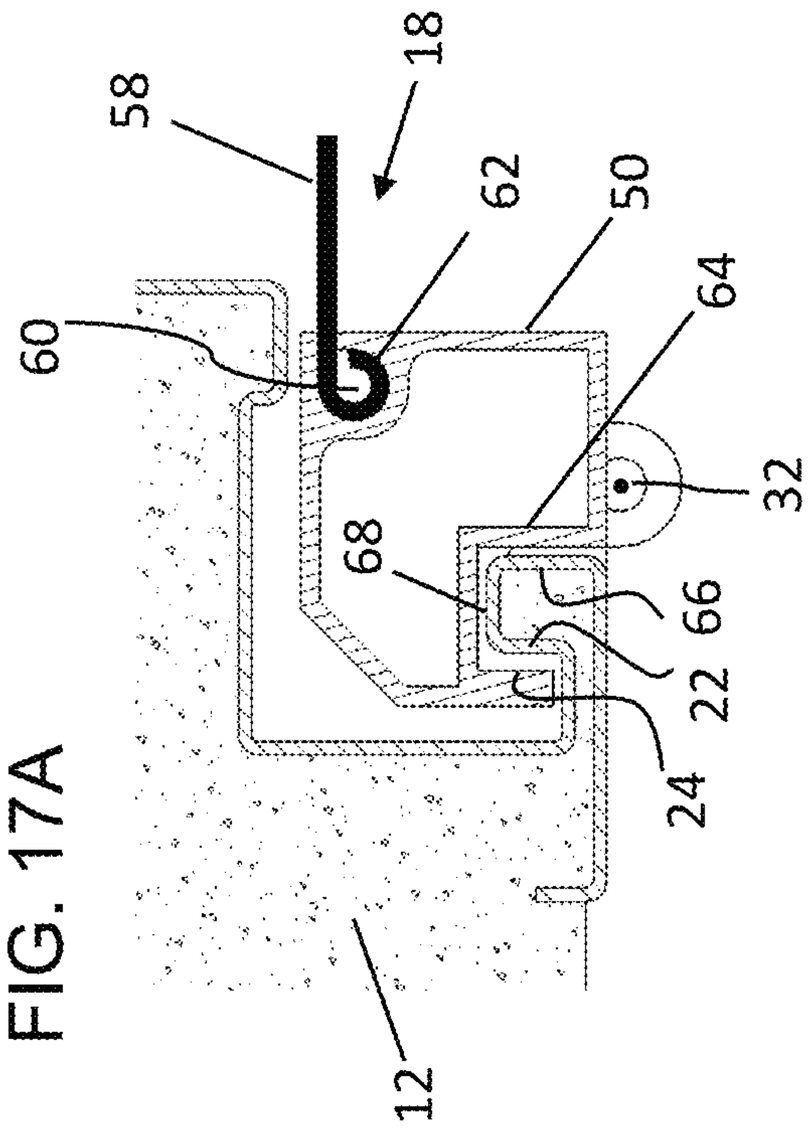


FIG. 17A

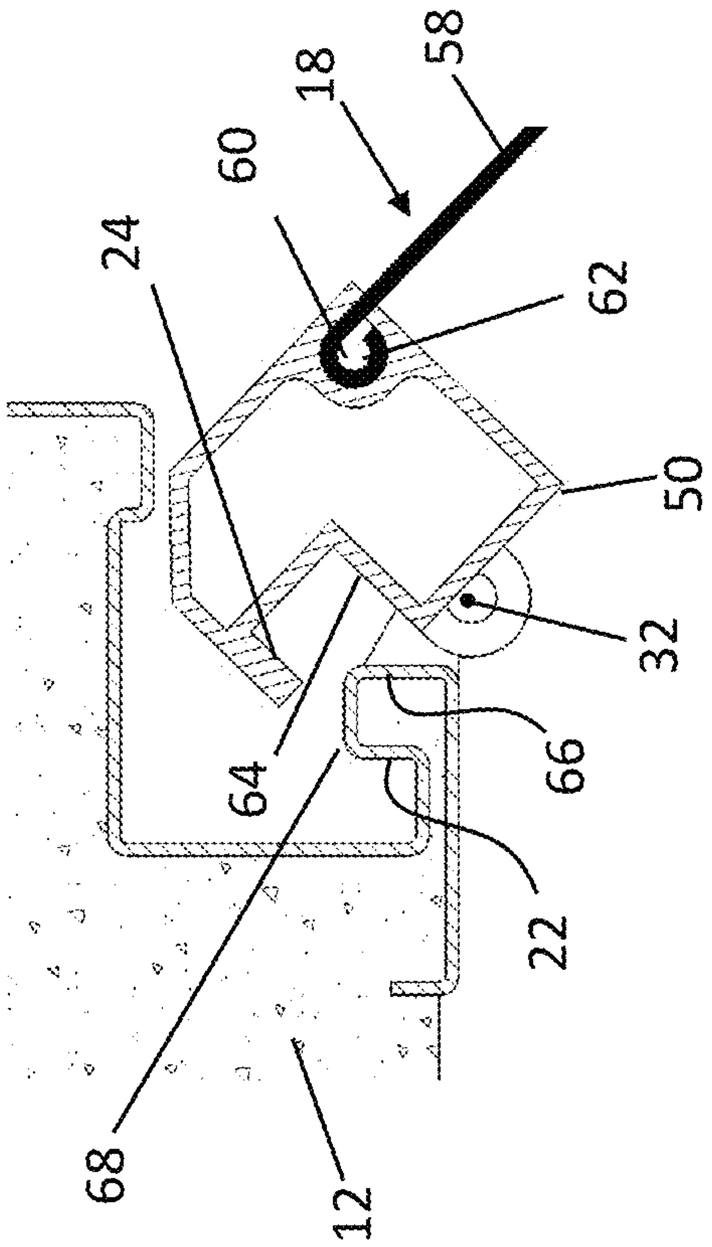


FIG. 17B

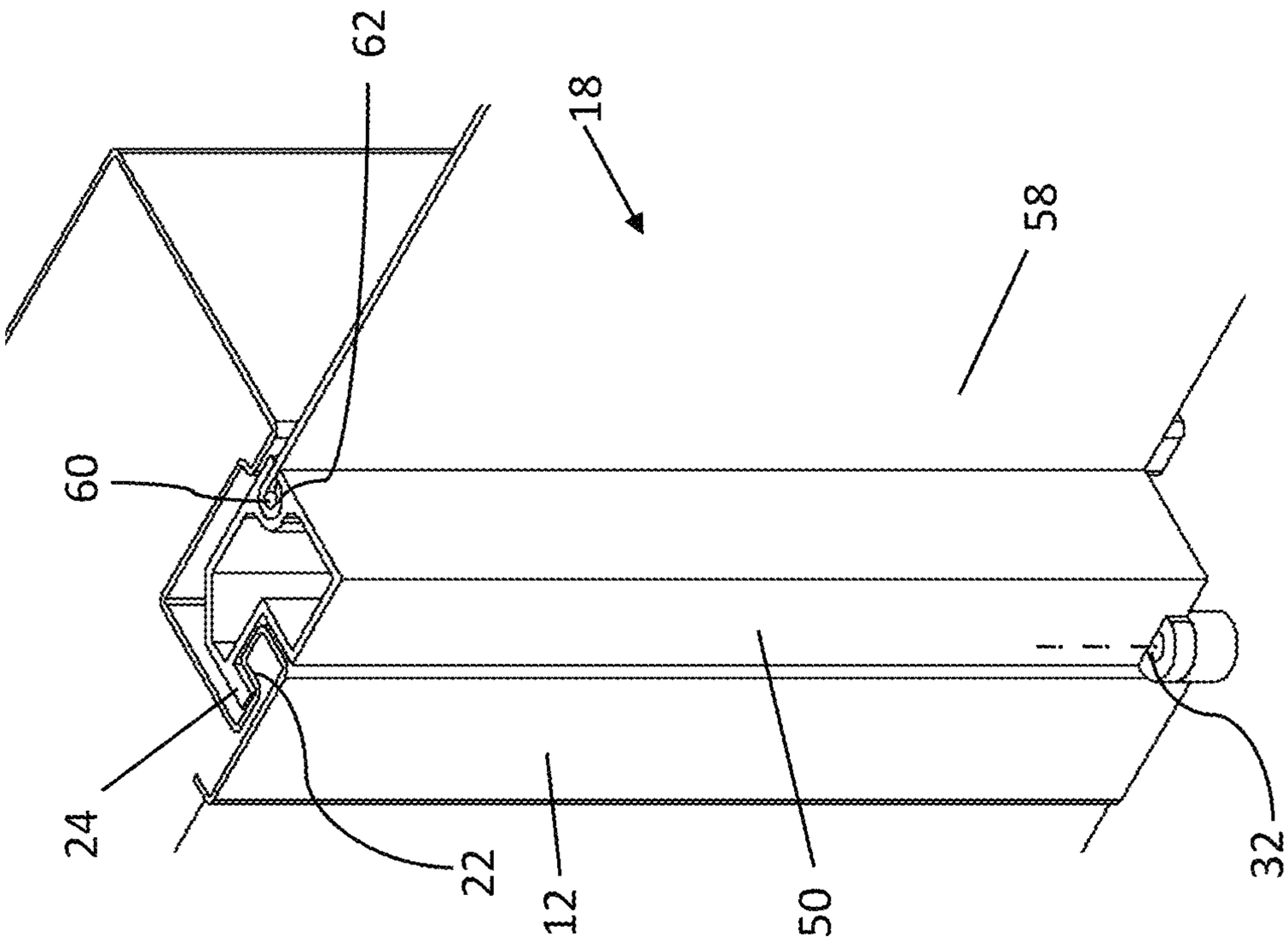


FIG. 16

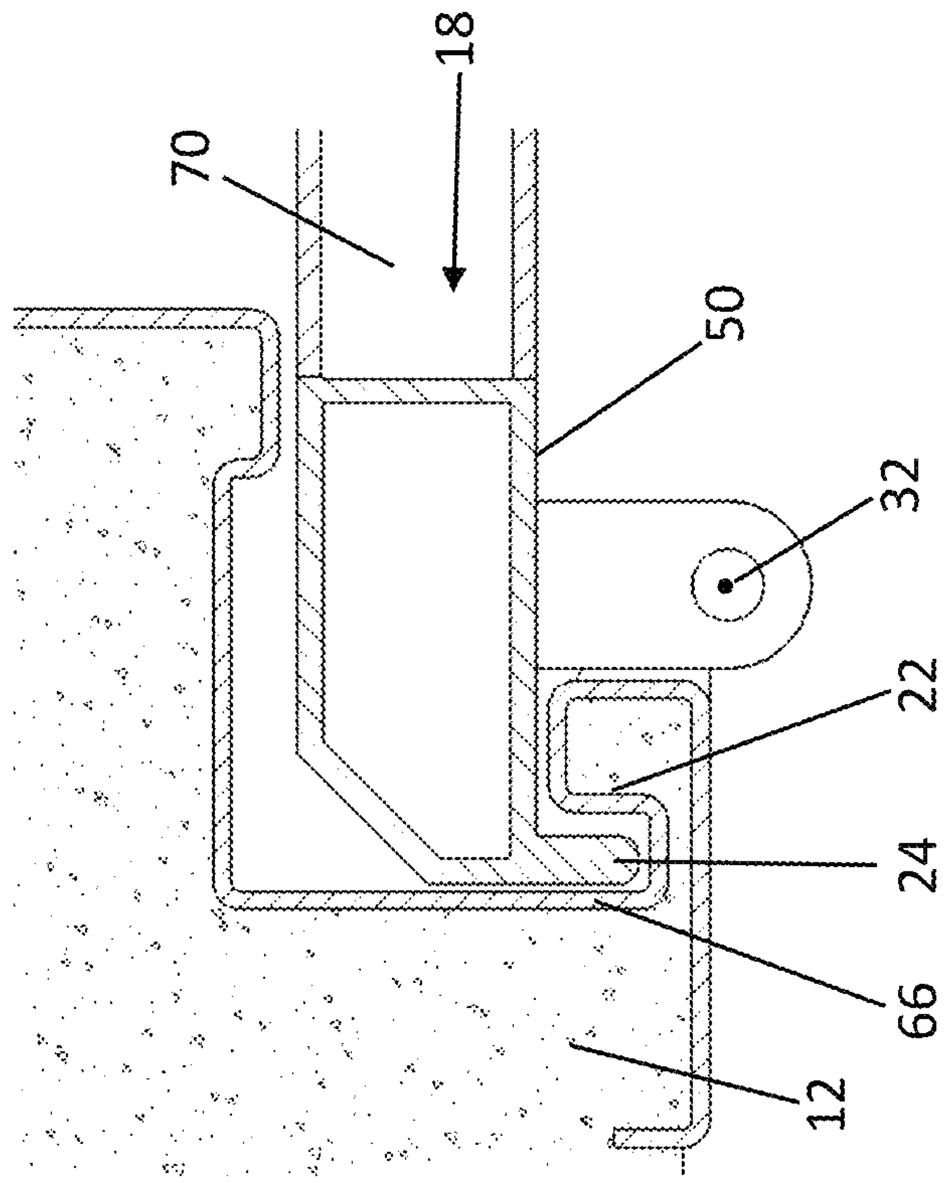


FIG. 18B

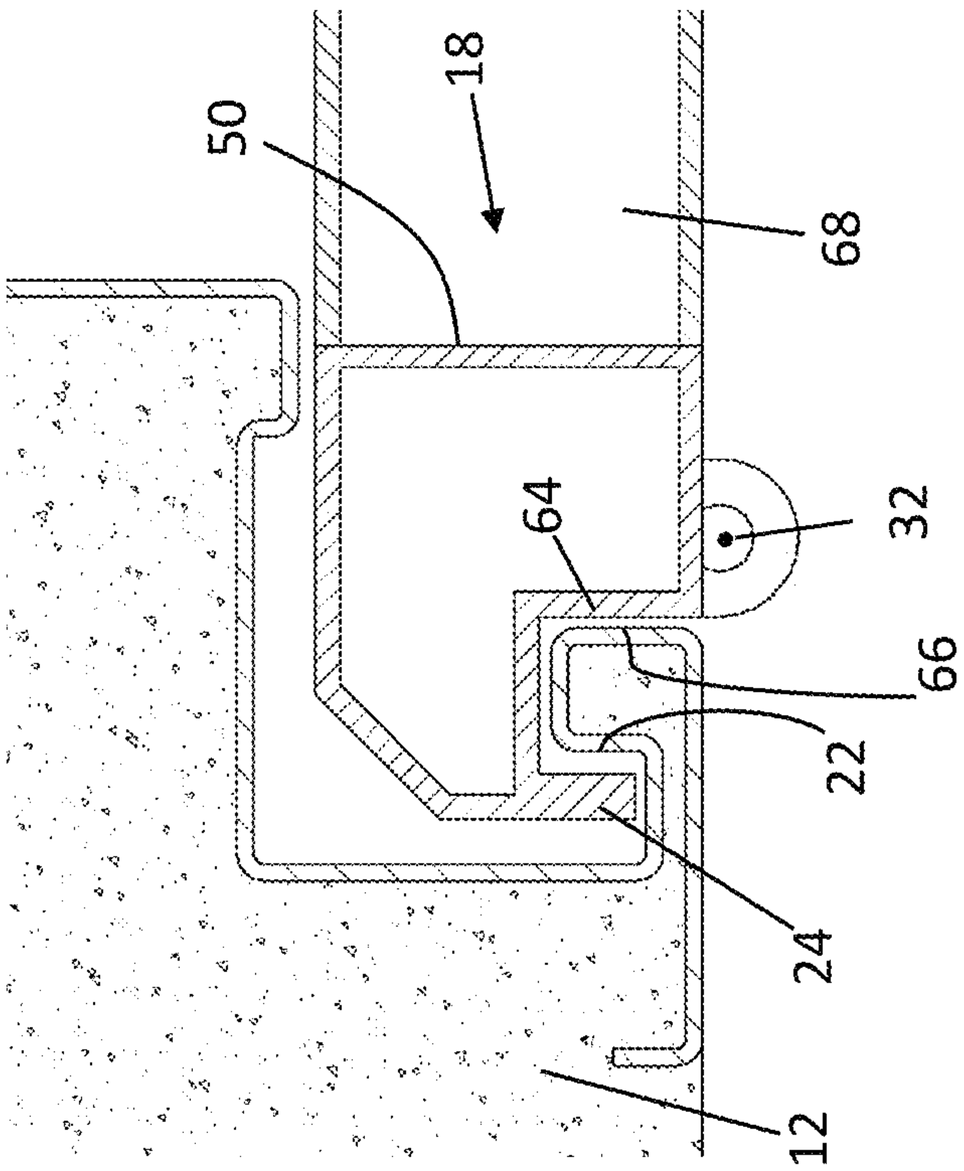


FIG. 18A

DOOR WITH SUPPLEMENTARY HINGE-SIDE ENGAGEMENT

FIELD AND BACKGROUND OF THE INVENTION

The present invention relates to hinged closures such as doors and windows and, in particular, it concerns a hinged closure with supplementary engagement at the hinge-side of the panel.

In a wide range of applications, it is desirable to provide hinged closures with reinforcement. For example, in security doors, it is known to provide a number of pins projecting from the door which engage corresponding holes in the hinge jamb, thereby providing enhanced resistance to forces trying to force the panel away from the frame.

Such pins generally project within the plane of the panel, such that they do not oppose forces that would tend to pull the panel away from the hinge jamb within the plane of the door frame. Such forces may occur under a range of circumstances, such as when a panel becomes bowed under an impact or blast.

SUMMARY OF THE INVENTION

The present invention provides various embodiments of a hinged closure with supplementary engagement at the hinge-side of the panel.

According to the teachings of an embodiment of the present invention there is provided, an apparatus comprising: (a) an opening bounded by a frame including a hinge jamb, the frame defining a plane of closure; (b) a panel; (c) a hinge arrangement associated with the panel and the hinge jamb and configured to hang the panel relative to the opening so as to be swingable between an open position removed from the opening and a closed position in which the panel is aligned parallel to the plane of closure within the opening; and (d) an engagement configuration comprising: (i) a ledge located in fixed relation to the hinge jamb, and (ii) a flange rigidly associated with the panel, the engagement configuration being configured such that the panel swings freely between the open position and the closed position, and such that, when the panel assumes the closed position, the flange is brought into facing relation with the ledge such that force directed to displace the panel within the plane of closure away from the hinge jamb acts to bring the flange into engagement with the ledge.

According to a further feature of an embodiment of the present invention, the flange is part of a closed profile forming at least part of the panel.

According to a further feature of an embodiment of the present invention, the closed profile is formed from at least one layer of sheet metal bent to form the flange and the closed profile.

According to a further feature of an embodiment of the present invention, the closed profile is formed from a single piece of sheet material bent so as to form the flange and the closed profile.

According to a further feature of an embodiment of the present invention, the closed profile is an extruded profile.

According to a further feature of an embodiment of the present invention, the panel is formed from at least two sheets of metal each extending substantially an entire width of the panel.

According to a further feature of an embodiment of the present invention, the closed profile includes an elongated recess, and wherein the panel includes a sheet of metal formed with a lateral folded lip, the elongated recess and the lateral folded lip being configured for sliding interengagement.

According to a further feature of an embodiment of the present invention, the closed profile further comprises a shoulder, and wherein the hinge jamb further comprises an abutment surface, the shoulder and the abutment surface being deployed such that, when the panel assumes the closed position, the shoulder and the abutment surface are brought into facing relation such that force directed to displace the panel within the plane of closure towards the hinge jamb acts to bring the shoulder into engagement with the abutment surface.

According to a further feature of an embodiment of the present invention, the flange and the shoulder are in facing relation defining between them an elongated recess of the closed profile, and wherein the ledge and the abutment surface are integrated into a projecting ridge of the hinge jamb, the projecting ridge coming into engagement with the elongated recess when the panel assumes the closed position.

According to a further feature of an embodiment of the present invention, the hinge jamb further comprises an abutment surface, the abutment surface being in facing relation with the ledge so as to define therebetween an elongated hinge-jamb recess, the flange being deployed to engage the elongated hinge jamb recess when the panel assumes the closed position with the flange in facing relation with the abutment surface such that force directed to displace the panel within the plane of closure towards the hinge jamb acts to bring the flange into engagement with the abutment surface.

According to a further feature of an embodiment of the present invention, the flange is part of a flange-extension rigidly attached to the panel.

According to a further feature of an embodiment of the present invention, the flange extension is bolted to the panel.

According to a further feature of an embodiment of the present invention, the flange extension is geometrically interlocked with the panel.

According to a further feature of an embodiment of the present invention, the flange extension extends along a majority of a dimension of the panel parallel to the hinge jamb.

According to a further feature of an embodiment of the present invention, the hinge arrangement includes a hinge support strip fixedly attached to the hinge jamb and extending along a majority of a length of the hinge jamb, and wherein the ledge is provided by an internal face of a slot formed in and extending along, the hinge support strip.

According to a further feature of an embodiment of the present invention, the hinge support strip supports a plurality of hinge pin elements spaced along the hinge jamb, wherein a sum total length of the hinge pin elements is less than a sum total length of the ledge.

According to a further feature of an embodiment of the present invention, the engagement configuration is configured such that contact between the flange and the ledge occurs only on application of sufficient force to cause damage to the hinge arrangement.

According to a further feature of an embodiment of the present invention, the frame further comprises a strike jamb, and wherein the panel further comprises a lock mechanism having a locking element displaceable to engage the strike jamb.

According to a further feature of an embodiment of the present invention, the locking element is a hook element

configured to engage the strike jamb so as, to oppose forces directed to pull the panel away from the strike jamb.

BRIEF DESCRIPTION OF THE DRAWINGS

The invention is herein described, by way of example only, with reference to the accompanying drawings, wherein:

FIG. **1** is a front view of a door assembly, constructed an operative according to an embodiment of the present invention, including a panel closing a doorway;

FIG. **2** is a schematic isometric view of the door assembly of FIG. **1** with the surrounding wall cut-away, the door assembly shown with the panel partially open;

FIGS. **3**A and **3**B are enlarged schematic isometric views of a region of the panel of FIG. **1** illustrating a locking element in a retracted and a deployed state, respectively;

FIGS. **4**A and **4**B are enlarged isometric views of the door assembly of FIG. **1** illustrating an engagement configuration of the door assembly, shown with the panel in a closed and a partially-open state, respectively;

FIGS. **5**A-**5**C are partial horizontal cross-sectional views taken through the door assembly of FIG. **1** showing the region of the hinge jamb with the engagement configuration with the panel in a closed state, partially-open state and fully-open state, respectively;

FIG. **5**D is a view similar to FIG. **5**B taken at a different height such that it does not intersect the a pin element of the hinge;

FIGS. **5**E and **5**F are partial enlarged views of two variant implementations of an engagement configuration shown in FIG. **5**A;

FIG. **6** is a partial, cut-away isometric view of the door assembly of FIG. **1** illustrating a variant implementation of an engagement configuration, constructed and operative according to an embodiment of the present invention, shown with the panel in a closed state;

FIG. **7**A is a horizontal cross-sectional view taken through the embodiment of FIG. **6** with the panel in a closed state, the cross-section being taken in a region of a hinge pin, element;

FIGS. **7**B-**7**D are horizontal cross-sectional views taken through the embodiment of FIG. **6** not passing through a hinge pin element, shown with the panel in a closed state, a partially-open state and a further-open state, respectively;

FIG. **8** is a partial, cut-away isometric view of the door assembly of FIG. **1** illustrating a further variant implementation of an engagement configuration, constructed and operative according to an embodiment of the present invention, shown with the panel in a partially-open state;

FIGS. **9**A and **9**B are horizontal cross-sectional views taken through the embodiment of FIG. **8**, shown with the panel in a closed state and a partially-open state, respectively;

FIG. **10** is a partial, cut-away isometric view of the door assembly of FIG. **1** illustrating a further variant implementation of an engagement configuration, constructed and operative according to an embodiment of the present invention, shown with the panel in a closed state;

FIGS. **11**A and **11**B are horizontal cross-sectional views taken through the embodiment of FIG. **10**, shown with the panel in a closed state and a partially-open state, respectively;

FIG. **12** is a partial, cut-away isometric view of the door assembly of FIG. **1** illustrating a further variant implementation of an engagement configuration implemented with a panel including a closed profile formed from a single sheet of material, constructed and operative according to an embodiment of the present invention, shown with the panel in a closed state;

FIGS. **13**A and **13**B are partial, horizontal cross-sectional views taken through the door assembly of FIG. **12**, shown with the panel in a closed state and a partially-open state, respectively;

FIG. **14** is a partial, cut-away isometric view of the door assembly of FIG. **1** illustrating a further variant implementation of an engagement configuration implemented with a panel including a closed profile formed from two sheets of material, constructed and operative according to an embodiment of the present invention, shown with the panel in a closed state;

FIGS. **15**A and **15**B are partial, horizontal cross-sectional views taken through the door assembly of FIG. **14**, shown with the panel in a closed state and a partially-open state, respectively;

FIG. **16** is a partial, cut-away isometric view of the door assembly of FIG. **1** illustrating a further variant implementation of an engagement configuration implemented with a panel including an extruded closed profile, constructed and operative according to an embodiment of the present invention, shown with the panel in a closed state;

FIGS. **17**A and **17**B are partial, horizontal cross-sectional views taken through the door assembly of FIG. **16**, shown with the panel in a closed state and a partially-open state, respectively; and

FIGS. **18**A and **18**B are partial, horizontal cross-sectional views taken through further variant implementations of an engagement configuration, constructed and operative according to an embodiment of the present invention, shown in a closed state of the panel, modified for a thick panel implementation and a thin panel implementation, respectively.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

The present invention is an apparatus that provides a closure to a doorway or other opening.

The principles and operation of apparatus according to the present invention may be better understood with reference to the drawings and the accompanying description.

By way of introduction, it should be noted that reference is made herein to "doors" and "doorways" as non-limiting typical examples, but that the corresponding description should be understood to apply equally to other types of openings, such as for example windows.

Referring now to the drawings, FIGS. **1**-**5**D illustrate an apparatus constructed and operative according to an embodiment of the present invention. Generally speaking, the apparatus includes an opening **10** hounded by a frame including a hinge jamb **12**, typically in combination with a strike jamb **14** and a lintel **16**. The frame defines a "plane of closure", which is intuitively defined as the plane of the opening to be closed by a closure (panel), typically corresponding to a plane intersecting with the frame around an entire periphery of the frame.

The apparatus also includes a panel **18** which is hung on (i.e., mounted to) hinge jamb **12** via a hinge arrangement **20** so as to be swingable between an open position removed from opening **10** and a closed position in which panel **18** is aligned parallel to the plane of closure within opening **10**.

It is a particular feature of certain preferred embodiments of the present invention that the apparatus is also provided with an engagement configuration including a ledge **22**

located in fixed relation to hinge jamb **12**, and a flange **24** rigidly associated with panel **18**. The engagement configuration is configured such that it does not obstruct free swinging of the panel between the open position (FIGS. **5**B and **5**C) and the closed position (FIG. **5**A), and such that, when the panel assumes the closed position, the flange is brought into facing relation with the ledge such that force directed to displace panel **18** within the plane of closure away from hinge jamb **12** acts to bring flange **24** into engagement with ledge **22**.

Certain preferred embodiments of the present invention thus provide greatly enhanced anchoring of panel **18** to hinge jamb **12**. Specifically, under conditions of high strain, such as from a blast wave or from a heavy mechanical impact, a panel may be subjected to forces sufficient to damage and compromise support of panel **18** via pin elements of hinge arrangement **20**. The engagement configuration illustrated here is highly effective even when forces act to try to separate panel **18** from hinge jamb **12** within the plane of closure, such as may occur on bowing of panel **18**. The engagement configuration of flange **24** and ledge **22**, which may advantageously extend along a greater portion of the height of the hinge jamb **12** than the extent of the hinge pin elements, and most preferably, along a majority of the height dimension of hinge jamb **12**, provides highly effective retention of panel **18** against separation from hinge jamb **12**, even under in-plane forces.

A further feature of certain embodiments of the present invention as illustrated here is that hinge arrangement **20** includes a hinge support strip **26** fixedly attached to an outward facing surface of hinge jamb **12** and extending along a majority of a length of the hinge jamb. In this case, ledge **22** is preferably provided by an internal face of a slot **28** formed in, and extending along, hinge support strip **26**. The use of hinge support strip **26** fixed to an outward facing surface of hinge jamb **12** renders this configuration of the present invention highly suitable for retrofit adaptation of a conventional doorframe. Since attachment is over a large area, for example via a series of spaced-apart bolts **30** (see FIG. **1**), hinge support strip **26** can be strongly anchored to hinge jamb **12** to withstand forces up to required specifications for a wide range of applications.

It should be noted that the principles of the present invention are applicable both to inward-opening and outward-opening panels. In cases in which a panel is outward-opening, the hinge support strip **26** may be rendered tamper-resistant by use of countersunk bolts with drilled-out heads, or by using through-the-wall anchoring elements which are secured from the inside of a building (not shown). In some cases, configurations in which the components forming the engagement configuration are completely concealed from view, such as those of FIGS. **8**-**11**B, described below, may be preferred for outward-opening panels.

According to one non-limiting preferred example illustrated here, the hinge axis **32** provided by hinge support strip **26** is located set-in from the edge of the panel, such that flange **24** which projects from the extremity of the door undergoes motion with an outward component at the end of the closing motion of the door, thereby engaging slot **28**. The hinge axis position is also outside the plane of the panel. In other words, if the main body of panel **18** is viewed as bounded by two planes, at the front and back surfaces of the panel, hinge axis **32** is, located outside the space bounded by those planes, and slightly spaced therefrom. This configuration also facilitates a large angle of motion of panel **18**, for example, in excess of 160°, and in some cases approximately 180°, as illustrated in FIG. **5**C.

As mentioned above, the hinge pin elements defining hinge axis **32** support panel **18** for normal hinged motion, but are not the primary load-bearing elements in case of extreme loading. For this reason, in certain preferred implementations, hinge support strip **26** supports a plurality of hinge pin elements spaced along hinge jamb **12**, where a sum total length of the hinge pin elements is less than a sum total length of ledge **22**. Typically, the engagement configuration is configured with a clearance space between the facing surfaces such that contact between flange **24** and ledge **22** occurs only on application of sufficient force to cause damage to hinge arrangement **20**.

The orientations of the facing surfaces of flange **24** (when the panel is closed) and ledge **22** as illustrated here are perpendicular to the plane of closure and run parallel to the length of hinge jamb **12**. Optionally, a slight undercut angle may be provided (FIG. **5**E) so that, under a load, flange **24** and ledge **22** lock against each other and cannot be released without pushing the panel back towards the hinge jamb. Conversely, implementations with a slight release angle (FIG. **5**F) also fall within the scope of the present invention, and this may provide additional design freedom for implementation of the engagement configuration so that it does not impinge on the freedom of swinging motion of the panel. Any such release angle should be sufficiently small that frictional engagement between surfaces of flange **24** and ledge **22** negates any tendency to slide across each other and release engagement under an applied load.

It should be appreciated that the hinge-side reinforcements of the present invention may be used to advantage with any and all types, of panels and locking mechanisms. In many cases, panel **118** features a lock mechanism having one or more locking elements **34** displaceable to engage the strike jamb. The lock mechanism may be any conventional lock mechanism, and for conciseness, will not be described here in detail. In certain particularly preferred implementations, some or all of locking elements **34** are hook elements (FIGS. **3**A and **3**B) configured to engage the strike jamb **14** so as to oppose forces directed to pull the panel away from the strike jamb. This engagement complements the supplementary hinge jamb side engagement so as to provide highly effective retention of panel **18** within the opening under a wide range of loading conditions.

Turning now to FIGS. **6** and **7**A-**70**, these illustrate a variant implementation of hinge support strip **26** and flange **24**. In this case, hinge axis **32** is located to the side of panel **18** (not set in, from the edge as above), and the engagement configuration is formed by two complementary profiles. A first profile, integrated with hinge support strip **26**, extends outwards from hinge jamb **12** and bends over to provide ledge **22**. A second profile, bolted or otherwise fixed to (or integrally formed with) panel **18**, has a U-shaped profile which provides flange **24**. These profiles preferably extend along a majority of a height of the hinge jamb and panel, interrupted at a number of locations by a conventional hinge structure (see FIG. **7**A). The resulting engagement configuration is structurally and functionally equivalent to that of FIGS. **1**-**5**D described above, and will not be described here in further detail.

Turning now to FIGS. **8**-**18**B, these illustrate alternative configurations of the hinge side engagement of the present invention which require a modified (i.e., non-standard) hinge jamb structure. Specifically, in these cases, ledge **22** is formed as a ledge internal to hinge jamb **12**, within an internal recess **36** within hinge jamb **12**. This ensures that the

engagement configuration is tamperproof when closed, and facilitates implementations for bearing particularly large loads.

In FIGS. **8-11**B, flange **24** as illustrated here is part of a flange-extension **38** rigidly attached to panel **18**. In the example of FIGS. **8-9**B, flange extension **38** is bolted to the panel by a set of spaced-apart bolts **40** anchoring the flange extension to the main part of panel **18**. Flange extension **38** preferably extends along a majority, and most preferably the entirety, of a dimension of panel **18**. In this case, the engagement configuration is spaced from the hinge arrangement **20** such that the engagement configuration can be continuous, or near continuous, along the height of panel **18**.

The example of FIGS. **10-11**B is structurally and functionally equivalent to that of FIGS. **8-9**B, except that flange extension **38** is in this case geometrically interlocked with the panel **18**. The geometrical interlocking may be achieved by any suitable interlocking configuration such as, for example, a dovetail joint or a T-rail joint interconnection. Attachment of flange extension **38** may be performed by sliding the parts together prior to mounting of panel **18** on hinge jamb **12**.

Turning now to FIGS. **12-18**B, these illustrate a number of further implementations of the present invention in which flange **24** is part of a closed profile **50** forming at least part of panel **18**. In this context, the term "closed profile" is used to refer to a structural element formed from material with a wall thickness less than the overall dimension of the profile, and where the shape of the profile in cross-section is closed, or substantially closed, thereby giving the element enhanced structural strength. The profile may have openings in certain cross-sections corresponding to localized holes for venting, filling, attachment to other elements, or for any other reason. The profile typically has an enclosed volume, which may be empty (or contain air) to form a hollow profile, or may be filed with foam or other filler with desired structural, acoustic or other properties. Depending upon the manufacturing technique used, the profile may be formed open at its ends, and is typically plugged at one or both of its ends by a suitable cap, typically incorporated into a transverse element extending along the top and/or bottom edge of the panel knot shown).

In the examples of FIGS. **12-13**B and **14-15**B, closed profile **50** is formed from at least one layer of sheet material, typically sheet metal, bent to form flange **24** and the closed profile. In the examples of FIGS. **16-17**B, an extruded profile is used to anchor a sheet-metal panel element. The use of sheet metal in the construction of panels, such as for doors, provides a range of advantages. Such panels are typically relatively low in cost to produce via processes such as roll-forming or press-forming, and provide considerable mechanical strength. In security and blast-protection applications, sheet metal can withstand high loads for a given weight by acting as a diaphragm across the opening. However, such properties are only exhibited if the sheet metal is reliably anchored at its periphery. The various embodiments of the present invention illustrated herein provide effective solutions for such anchoring at the hinge side of the panel. Analogous closed-profile structures (not shown) are preferably used also at the strike jamb side of the panel in combination with a suitable locking mechanism, such as the mechanism illustrated above with reference to FIGS. **3**A and **38**.

In the case of FIGS. **12-138**, closed profile **50** is formed from a single piece of sheet material **52** bent so as to form flange **24** and closed profile **50**. Most preferably, the same single piece of sheet material also extends across a majority of the panel width, and typically also forms a closed profile at the opposite (strike jamb) side of the panel. Flange **24** is preferably formed by a part of the sheet folded back on itself to form a double-thickness flange. Optionally, the two thicknesses of the sheet forming flange **24** may be bonded together, for example, by spot welding or riveting. In order to provide enhanced rigidity, the folded edge of the sheet is preferably bonded to the part of the sheet against which it closes at bond **54** to form the closed profile. This bonding may be achieved by welding or any other suitable joining technique known for joining sheet metal. The bond **54** is preferably continuous, or at multiple locations sufficiently closely spaced as to provide rigidity similar to that which would be achieved by a continuous joint.

Turning now to FIGS. **14-15**B, these illustrate an alternative embodiment in which panel **18** is formed primarily from two layers **56***a*, **56***b* of sheet material which cooperate to form a closed profile exhibiting a projecting flange **24**. The two layers may meet and be joined at additional regions across the width of the panel, or may be joined only at the two edges. The panel is typically filled with, a suitable filler material (not shown).

Turning now to FIGS. **16-17**B, these illustrate a further embodiment of the present invention according to which closed profile **50** is implemented as an extruded profile. The extruded profile may be formed from any extrudable material suitable for forming part of a door or window panel. Particularly preferred examples include aluminum and aluminum alloys, as well as carbon fiber-reinforced polymers.

In the example illustrated here, the closed profile is configured for mounting and retaining a sheet **58** of material, typically sheet metal, which forms a structural part of the panel. To this end, closed profile **50** here includes an elongated recess **60** which has an opening of dimension to receive a single thickness of sheet **58** and a shaped internal channel. Sheet **58** is formed with a lateral folded lip **62**, which may be an L-shaped folded lip, or may be bent back on itself to form a doubled-over edge as shown here. Elongated recess **60** and lateral folded lip **62** are configured for sliding interengagement such that the folded lip can be slid into engagement with the shaped internal channel of recess **60** and is retained thereby against tension applied within the plane of the sheet. The hinge jamb engagement configuration provided by flange **24** and ledge **22** together with the anchoring of sheet **58** within recess **60** provides highly effective retention of sheet **58** on the hinge-jamb side of the panel. By using similar retention of sheet **58** in a strike jamb-side profile (not shown), and a suitable locking, mechanism for retaining the strike jamb-side profile to the strike jamb (such as that illustrated above with reference to FIGS. **3**A and **3**B), highly effective retention of sheet **58** is achieved, providing the aforementioned load-bearing properties of a diaphragm stretched across the opening in a light-weight and low-cost structure.

Turning now to a further preferred feature of certain embodiments of the present invention, it has been found that, depending upon the structure of the strike jamb-side locking mechanism and/or dependent upon circumstances in which a load is applied to try to pry the door away from the strike jamb, forces applied to the panel may sometimes include a large force within the plane of the closure towards the hinge jamb.

In the context of the particular ledge and flange interlocking of embodiments of the present invention, certain preferred embodiments of the present invention, have the hinge-side extremity of the panel located within a recess within hinge jamb **12**. Accordingly, certain particularly

preferred embodiments of the present invention provide surfaces deployed to provide effective support to oppose forces acting to displace the panel towards the hinge jamb.

Specifically, referring by way of a non-limiting example to the embodiments formed with a closed profile **50**, the closed profile preferably features a shoulder **64**, and hinge jamb **12** preferably features an abutment surface **66**. Shoulder **64** and abutment surface **66** are deployed such that, when panel **18** assumes its closed position, shoulder **64** and abutment surface **66** are brought into facing relation such that force directed to displace panel **18** within the plane of closure towards hinge jamb **12** acts to bring shoulder **64** into engagement with abutment surface **66**.

In the particularly preferred examples of FIGS. **12-18**A, flange **24** and shoulder **64** are in facing relation, defining between them an elongated recess of closed profile **50**. Ledge **22** and abutment surface **66** are then advantageously integrated into a projecting ridge **68** of hinge jamb **12** that is deployed so that it comes into engagement with the elongated recess of profile **50** when panel **18** assumes its closed position. It will be noted in the geometrical arrangement of FIGS. **12-18**A that a certain clearance is required between flange **24** and ledge **22** to allow the required relative motion under rotation about hinge axis **32** to the closed position of the panel. Shoulder **64** and abutment surface **66**, on the other hand, are preferably brought into close facing relation, typically with a clearance of no more than a few millimeters therebetween, and may in some cases be brought into direct contact, in the closed state of the panel.

Although illustrated here as being surfaces perpendicular to the plane of closure, it should be noted that shoulder **64** and abutment surface **66** may also be implemented with a range of different angles, analogous to the variant implementations of ledge **22** and flange **24** discussed above with reference to FIG. **5**A.

Turning finally to FIGS. **18**A and **18**B, these illustrate how the abutment surfaces may need to be varied in order to provide bidirectional support against in-plane forces for a range of different panel thicknesses. In the case of FIG. **18**A, the form of closed profile **50** is essentially similar to that of FIG. **17**A, except that the profile is here shown schematically with a generic thick panel structure **68**. The aforementioned structure of an elongated recess between flange **24** and shoulder **64** is very suitable for providing the aforementioned bidirectional support.

FIG. **18**B, on the other band, shows an implementation for use with a thin panel structure **70**, and where it is desired to employ a correspondingly thin structure for closed profile **50**. In this case, hinge jamb **12** is preferably implemented with an abutment surface **66** in facing relation With ledge **22** so as to define therebetween an elongated hinge-jamb recess. Flange **24** is deployed to engage this elongated hinge-jamb recess when the panel is in its closed position with a surface of flange **24** in facing relation with abutment surface **66** such that force directed to displace panel **18** within the plane of closure towards hinge jamb **12** acts to bring flange **24** into engagement with abutment surface **66**.

It will be appreciated that the above descriptions are intended only to serve as examples, and that many other embodiments are possible within the scope of the present invention as defined in the appended claims.

What is claimed is:

1. An apparatus comprising:

(a) an opening bordered by a hinge jamb and a strike jamb, said hinge jamb and said strike jamb defining a plane of closure;

(b) a panel;

(c) a hinge arrangement associated with said panel and said hinge jamb and configured to hang said panel relative to said opening so as to be swingable about a hinge axis between an open position removed from said opening towards an opening side of the plane of closure and a closed position in which said panel is aligned parallel to said plane of closure within the opening, the hinge axis being set-in from an edge of the panel closest to said hinge jamb; and

(d) an engagement arrangement comprising:

(i) a ledge located in fixed relation to said hinge jamb, and

(ii) a flange rigidly associated with said panel,

said engagement arrangement being configured such that said engagement arrangement does not obstruct swinging of said panel between said open position and said closed position, and such that, when said panel assumes said closed position, said flange is brought into facing relation with said ledge such that force directed to displace said panel within said plane of closure away from said hinge jamb acts to bring said flange into engagement with said ledge,

and wherein said flange projects from a closed profile that forms at least part of said panel, and wherein at least part of said closed profile extends beyond said hinge axis so that said closed profile comes into overlapping relation behind part of said hinge jamb as viewed from the opening side of the plane of closure when said panel is in said closed position.

2. The apparatus of claim **1**, wherein said closed profile is formed from at least one layer of sheet metal bent to form said flange and said closed profile.

3. The apparatus of claim **1**, wherein said closed profile is formed from a single piece of sheet material bent so as to form said flange and said closed profile.

4. The apparatus of claim **1**, wherein said closed profile is an extruded profile.

5. The apparatus of claim **1**, wherein said panel is formed from at least two sheets of metal each extending substantially an entire width of said panel.

6. The apparatus of claim **1**, wherein said closed profile includes an elongated recess, and wherein said panel includes a sheet of metal formed with a lateral folded lip, said elongated recess and said lateral folded lip being configured for sliding interengagement.

7. The apparatus of claim **1**, wherein said closed profile further comprises a shoulder, and wherein said hinge jamb further comprises an abutment surface, said shoulder and said abutment surface being deployed such that, when said panel assumes said closed position, said shoulder and said abutment surface are brought into facing relation such that force directed to displace said panel within said plane of closure towards said hinge jamb acts to bring said shoulder into engagement with said abutment surface.

8. The apparatus of claim **7**, wherein said flange and said shoulder are in facing relation defining between them an elongated recess of said closed profile, and wherein said ledge and said abutment surface are integrated into a projecting ridge of said hinge jamb, said projecting ridge coming into engagement with said elongated recess when said panel assumes said closed position.

9. The apparatus of claim **1**, wherein said hinge jamb further comprises an abutment surface, said abutment surface being in facing relation with said ledge so as to define therebetween an elongated hinge jamb recess, said flange being deployed to engage said elongated hinge jamb recess when said panel assumes said closed position with said flange in facing relation with said abutment surface such that

force directed to displace said panel within said plane of closure towards said hinge jamb acts to bring said flange into engagement with said abutment surface.

10. The apparatus of claim **1**, wherein said engagement arrangement is configured such that contact between said flange and said ledge occurs only on application of sufficient force to cause damage to said hinge arrangement.

11. The apparatus of claim **1**, wherein said panel further comprises a lock mechanism having a locking element displaceable to engage said strike jamb.

12. The apparatus of claim **11**, wherein said locking element is a hook element configured to engage said strike jamb so as to oppose forces directed to pull said panel away from said strike jamb.

13. The apparatus of claim **1**, wherein said hinge jamb is formed with a recess, and wherein at least part of said closed profile is deployed within said recess in said closed position of said panel.

14. The apparatus of claim **1**, wherein said closed profile extends to said edge of said panel.

15. The apparatus of claim **1**, wherein said flange projects from said closed profile in a direction perpendicular to said plane of closure when said panel is in said closed position.

16. The apparatus of claim **1**, wherein a surface of said flange facing said ledge is angled such that, under a load, said flange and said ledge lock against each other.

17. An apparatus comprising:

(a) an opening bordered by a hinge jamb and a strike jamb, said hinge jamb and said strike jamb defining a plane of closure;

(b) a panel;

(c) a hinge arrangement associated with said panel and said hinge jamb and configured to hang said panel relative to said opening so as to be swingable between an open position removed from said opening and a closed position in which said panel is aligned parallel to said plane of closure within the opening; and

(d) an engagement arrangement comprising:

(i) a ledge located in fixed relation to said hinge jamb, and

(ii) a flange rigidly associated with said panel,

said engagement arrangement being configured such that said engagement arrangement does not obstruct swinging of said panel between said open position and said closed position, and such that, when said panel assumes said closed position, said flange is brought into facing relation with said ledge such that force directed to displace said panel within said plane of closure away from said hinge jamb acts to bring said flange into engagement with said ledge,

wherein said hinge arrangement includes a hinge support strip fixedly attached to said hinge jamb and extending along at least part of a length of said hinge jamb, and wherein said ledge is provided by an internal face of a slot formed in, and extending along, said hinge support strip.

18. The apparatus of claim **17**, wherein said hinge support strip supports a plurality of hinge pin elements spaced along said hinge jamb, wherein a sum total length of said hinge pin elements is less than a sum total length of said ledge.

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